103

S. HRG. 103–59

NASA's FISCAL YEAR 1994 BUDGET

Y 4. C 73/7: S. HRG. 103-59

NASA's Fiscal Year 1994 Budget, S.H...

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED THIRD CONGRESS

FIRST SESSION

APRIL 20, 1993

Printed for the use of the Committee on Commerce, Science, and Transportation

SEP 9 1993

U.S. GOVERNMENT PRINTING OFFICE

67–115cc WASHINGTON : 1993

For sale by the U.S. Government Printing Office
Superintendent of Documents, Congressional Sales Office, Washington, DC 20402
ISBN 0-16-041118-1

103

S. HRG. 103–59

NASA's FISCAL YEAR 1994 BUDGET

Y 4. C 73/7: S. HRG. 103-59

NASA's Fiscal Year 1994 Budget, S.H...

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED THIRD CONGRESS

FIRST SESSION

APRIL 20, 1993

Printed for the use of the Committee on Commerce, Science, and Transportation

SEP 9 1993

U.S. GOVERNMENT PRINTING OFFICE

67–115cc WASHINGTON : 1993

For sale by the U.S. Government Printing Office
Superintendent of Documents, Congressional Sales Office, Washington, DC 20402
ISBN 0-16-041118-1

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ERNEST F. HOLLINGS, South Carolina, *Chairman*

DANIEL K. INOUYE, Hawaii
WENDELL H. FORD, Kentucky
J. JAMES EXON, Nebraska
JOHN D. ROCKEFELLER IV, West Virginia
JOHN F. KERRY, Massachusetts
JOHN B. BREAUX, Louisiana
RICHARD H. BRYAN, Nevada
CHARLES S. ROBB, Virginia
BYRON L. DORGAN, North Dakota
BOB KRUEGER, Texas

JOHN C. DANFORTH, Missouri
BOB PACKWOOD, Oregon
LARRY PRESSLER, South Dakota
TED STEVENS, Alaska
JOHN McCAIN, Arizona
CONRAD BURNS, Montana
SLADE GORTON, Washington
TRENT LOTT, Mississippi
JUDD GREGG, New Hampshire

KEVIN G. CURTIN, *Chief Counsel and Staff Director*
JONATHAN CHAMBERS, *Republican Staff Director*

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

JOHN D. ROCKEFELLER IV, West Virginia, *Chairman*

ERNEST F. HOLLINGS, South Carolina
JOHN F. KERRY, Massachusetts
RICHARD H. BRYAN, Nevada
CHARLES S. ROBB, Virginia
BOB KRUEGER, Texas

CONRAD BURNS, Montana
LARRY PRESSLER, South Dakota
TRENT LOTT, Mississippi
JUDD GREGG, New Hampshire

CONTENTS

	Page
Opening statement of Senator Burns	18
Prepared statement	19
Opening statement of Senator Bryan	4
Prepared statement	5
Opening statement of Senator Hollings	4
Opening statement of Senator Rockefeller	1

WITNESS

Goldin, Daniel S., Administrator, National Aeronautics and Space Administration	6
Prepared statement	9

APPENDIX

Questions Asked by Senator Burns and Answers Thereto by NASA	43

NASA's FISCAL YEAR 1994 BUDGET

TUESDAY, APRIL 20, 1993

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY,
AND SPACE OF THE COMMITTEE ON
COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:42 a.m., in room SR-253 of the Russell Senate Office Building, Hon. John D. Rockefeller IV (chairman of the subcommittee) presiding.

Staff members assigned to this hearing: Steven O. Palmer, senior professional staff member; and Louis C. Whitsett, minority staff counsel.

OPENING STATEMENT OF SENATOR ROCKEFELLER

Senator ROCKEFELLER. Good morning everyone. I apologize for Senator Bryan's being so early.

The subcommittee today begins its review of the fiscal year 1994 budget request for the National Aeronautics and Space Administration. This is also the first opportunity in the 103d Congress for the Subcommittee on Science, Technology, and Space to hear from the NASA Administrator on the state of our Nation's space and aeronautics programs.

It is definitely a new year. I think that has to be said. One in which change has been the watchword and will continue to be. We have a new President and a new Vice President, both who are not only committed to change, but to ensuring the success of NASA and its programs. We also have before us a NASA administrator who only this month completed his first year in the position, and is considered, at least by this Member, to be highly respected.

And the subcommittee, lo and behold, has a new chair not just on the Democratic side but also an excellent new ranking Republican member as well, the distinguished Senator from Montana, Senator Burns. He and I have the good fortune of continuing a working relationship, which goes back since the time that he was here. We have had the same relationship on another subcommittee. And although that may sound like drivel to most of the world, it is very important, in fact, when a ranking and chair relationship work well on the subcommittee basis, as it is just as important and sometimes more important when the staff relationship between Democrat and Republican works well, as it does.

As a longstanding member of this subcommittee, I share the desire of the NASA workforce, those in the aerospace and the space

science communities, as well as the American people, to see that that U.S. space program continues to achieve long-term success.

Like most Americans, I remember the glory days of our space program, from the first launch of Alan Shepard in Freedom 7, to Neil Armstrong's tentative steps on the Moon 8 years after that, to the pictures of our solar system, wondrous and incredible, sent back to Earth by Mariner, Pioneer, and Voyager spacecraft. Despite these spectacular successes, however, NASA's ability to produce tangible results has suffered to some degree in recent years.

No one can dispute the fact that space exploration is a high-risk venture, but the American taxpaying public has a right to expect a return on their investment. In fact, they are getting rather insistent about that from Government. A recent but continuing pattern of design and operational flaws in a number of spacecraft and the space shuttle raises questions about the agency's ability to produce what has been promised.

This is not a criticism of the people of NASA; rather, it is aimed at those who have developed the policies that have resulted in a space program dominated by multibillion dollar initiatives that often take decades to develop and launch. A lot of that finger pointing should go at the U.S. Congress and the White House. We have changed signals so many times on NASA over the years that it would have been almost impossible for NASA to have done anything correctly. And more often than not, in the end, these missions which I was referring to have cost far in excess of original projections.

Certainly, the very best current example of this has been the Space Station Freedom. I am relieved and pleased that the administration has initiated a redesigned process in an effort to reduce the $30 billion cost that had been proposed for the earlier Space Station. But the future of the Space Station program cannot lie solely in cutting costs. The redesigned Space Station must be based on mission objectives that cannot be achieved by any other more cost-effective meetings.

That may be a difficult standard, in fact, to meet. But it seems to me that we cannot afford to continue to spend billions of dollars on NASA programs that have little, if any, benefit to the American taxpaying public.

A commentary by Michael Schrage that appeared in last week's Washington Post on the space program even argued that the Space Age is dead. I think that is wrong. But he made that argument. He stated that, "Space exploration has mutated from the central focus of America's science and technology dialog into a peripheral issue." He continued: "Space is not a meaningful part of our industrial competitiveness, technology infrastructure discussions, or even defense conversion policy."

Now, those are rather tough words. I do not share those sentiments, but there they are. And there are those out there in the policy world and the American public that do share those sentiments.

Simply put, NASA has had problems in recent years. And as chairman of this subcommittee, I want to understand why. More importantly, I want to use this position to help formulate policies that will ultimately strengthen our efforts in space and in aero-

nautics. In other words, I do not want for this subcommittee or this Congress to be part of the problem.

I want it to be part of the solution, both in its being aggressive in its oversight, but also aggressive in its own determination that we ourselves understand much more clearly than we have in the past the repercussions of the decisions which we sometimes make in a rather frivolous manner. And I want to be part of making sure that that happens.

Toward that end, I am pleased to see that greater emphasis has been proposed in the NASA budget for aeronautical research, given the direct impact that this work can have on our national competitiveness. Again, I was going back to national competitiveness.

I am prepared to help fight for NASA's budget in the Congress, provided a sensible plan for the future can be developed and articulated. Certainly, as chairman, I hold a certain responsibility in the Senate for ensuring that NASA's budget and program plan are sound investments in our Nation's future. However, let me be very clear up front, if NASA fails in this regard, I will not hesitate in taking steps to curtail NASA's ambitious spending plans in favor of other higher priority domestic programs that compete on a daily, hourly basis with the space program for what are scarce and what will be much more scarce Federal dollars.

This may sound harsh, but in my mind, this so-called tough love approach is needed, and is the only one that really makes sense and is the only one that NASA can really count on. It is sort of like President Clinton's recent meeting with Prime Minister Miyazawa.

I felt it was an entirely and wholly refreshing new entry into openness and honesty between Japan and the United States. And the President was saying exactly what he believed. He was not dealing in ambiguities. And the Japanese Prime Minister understood that. He understood the President to mean what he said, that the President is part of a new generation that has no angst or holdover from World War II, and therefore, he approaches Japan in a very pragmatic fashion.

There will be some in Japan who are worried about what the President said, but I predict to you that serious people in Japan will be much more relieved because, for the first time, they will be able to say there is the beginning of coherency of policy coming from the White House with respect to Japanese trade matters.

In fact, when Warren Christopher in the meeting at the White House piped in when they were talking about computers and said, "and I hope you buy American ones," that was an enormous signal, because heretofore the State Department has always been on the opposite side. They have always been only for the bilateral relationship, the diplomatic relationship, the political relationship. DOD, State, and NSC versus Commerce and USTR. Well, one team now. One point of view. That message had to be understood by the Japanese.

And that is the spirit in which I say, Mr. Administrator, this tough love approach. I think it is good. I think it ensures the future success, if we are both honest about it, of NASA and the American space and aeronautics program. Mr. Chairman, your comments, please.

OPENING STATEMENT OF SENATOR HOLLINGS

Mr. CHAIRMAN. Today, we begin our annual process of reviewing the NASA budget request. As in previous years, NASA comes before this committee with an ambitious agenda. However, unlike past budgets in recent years, the budget request for fiscal year 1994 is based on an approach that is intended to match the fiscal realities of today. As a result, I believe that the request is a good first step in making budgetary sense out of the NASA program.

I am pleased with a number of specific proposals included in the President's budget for NASA. The most prominent is the decision to restructure the Space Station Program in order to drive down the out-year program costs. While I will wait for completion of the redesign process before determining whether to support the new Space Station Program, I commend the President for his leadership in taking responsibility for the future of this program.

I also am pleased with NASA's attempt to focus its efforts, through a new Technology Investment Program, on development of technologies that can help not only the space program, but also our national economic competitiveness. Clearly NASA can play a key role in helping to ensure that all segments of U.S. industry have the benefit of its longstanding expertise in technology development. Many of the details have yet to be developed on this new technology investment package, and I look forward to any comments by the NASA Administrator today in this regard.

Finally, the budget request includes important aeronautics funding. The best example of a program where NASA's work has provided important benefits to the economy is its Aeronautics Research Program. Aerospace is a critical industry for our national economic competitiveness. I welcome the President's efforts to invest in this industry through proposed increases in funding for aeronautical research and technology development, as well as in the upgrading of the Nation's wind tunnels and other facilities.

For some time now, the U.S. space program has been adrift, lacking sufficient direction to carry it into the future with a well-defined, well-understood mission. We are a long way from having succeeded in addressing every problem that confronts NASA in this regard. Nevertheless, the NASA fiscal year 1994 budget and program plan are a welcome first step in turning things around for our space program.

Thank you, Mr. Chairman.

Senator ROCKEFELLER. Thank you, Mr. Chairman. I am very excited about the challenges that lie ahead. We have before us a window of opportunity—maybe not a very large one, but I think a very real one, to establish policies and programs that will strengthen not only our space program, but our national economic competitiveness as well. And this step is the first hearing—no, this step is the first step in that process, this hearing is.

On that inelegant ending, does the Senator from Nevada have something more articulate to say?

OPENING STATEMENT SENATOR BRYAN

Senator BRYAN. Mr. Chairman, thank you very much. I would ask unanimous consent that a statement that I have be made a part of the record.

Senator ROCKEFELLER. Of course.

[The prepared statement of Senator Bryan follows:]

PREPARED STATEMENT OF SENATOR BRYAN

Mr. Chairman, thank you for holding this hearing. I also thank Administrator Goldin for testifying today.

As we are all aware, some of our nation's greatest achievements were a result of NASA and the space program. Americans are justifiably proud of our achievements in space, and I will continue to support the many NASA programs which are justified and cost effective.

In today's strict budget constraints, however, not every program can be funded. American taxpayers clearly want to see more accountability in the spending of their hard earned dollars, and we need to bring the budget deficit under control. Every government program, even if it has reasonable goals, must be required to meet strict standards to ensure that they are cost effective, and truly in the interests of the taxpayers.

Several NASA programs simply do not meet these standards. In particular, there are two programs which I do not believe should be funded which I will discuss today.

One of these programs I have been trying to eliminate for a number of years—the Search for Extra-Terrestrial Intelligence, or SETI. This Committee, buy a vote of 11–6, voted to eliminate funding for this program as part of last year's NASA reauthorization. The prohibition on SETI funding was included in the bill finally signed by President Bush—an action which should have killed the program for good.

Unfortunately, this was not the case. To great public fanfare, NASA began scanning the skies for signs of extraterrestrials on Columbus Day, 1992. By changing the name of the project to the High Resolution Microwave Survey, NASA has evaded the clear intent of the authorization language, and continues to fund the program. This year, the request is for $12.3 million—money which I feel should not be spent, no matter what we call the program.

Another, and much more expensive, NASA program that concerns me is the Space Station. While I am pleased to see that the Clinton Administration is reevaluating and possibly downsizing the Space Station program, I believe it should be eliminated. The multi-billion dollar cost of even a reduced Space Station program cannot be justified in light of our huge budget deficit.

I am certain that the advocates of the above programs will attempt to justify the spending by pointing to the possible benefits. While I do not argue with the assertion that each of these programs may have some limited long term benefit, my point is that we simply need to view these programs in terms of our overall priorities. The $12 million that is being proposed for the HRMS (or SETI) program for next year, while relatively small by federal standards, could have great benefit in my home state of Nevada. For example, $12 million could pay for over 100 new homes in Las Vegas, pay the tuition of over 10,000 students at UNLV, or provide day care for over 3500 toddlers for one year.

Our enormous budget deficit dictates that we review the budget of every program with the greatest scrutiny and an eye for saving wherever we can. In my eye, and in the eyes of the taxpayers from my state, these two programs do not pass close scrutiny. Ultimately it is in the interests of NASA to root out programs that are costly and focus limited tax dollars on important high priority programs.

Senator BRYAN. I would just note, as you have, Mr. Chairman, the respect that I have for Mr. Goldin. Just to make an observation before we get into the round of questioning, all of these projects are nice. I do not think it is a question of us saying that they would not be nice for us to do. It is a question, it seems to me, of priorities, with a budget that is clearly running beyond control. And frankly, the message that I think most of us get as we return from this recess is: Cut spending.

I think that is across the spectrum politically and geographically in this country, and so I will want to ask some questions about the Space Station and a program that apparently knows a new life in a new name, the old SETI program, which apparently now is recast as the High Resolution Microwave Survey.

On that tempting note, let me close and defer to my round of questions.

Thank you very much, Mr. Chairman.

Senator ROCKEFELLER. Thank you, Senator.

I might just add one more thing also in my so-called truth-in-speaking policy, Mr. Administrator. And that is that I think you know very well that in years past I have been somewhat of an opponent of the Space Station. And in fact, in chairing the National Commission on Children over a period of 4 years, I often used the funding for the Space Station as a way to pay for some of our initiatives there.

What I want to say is that because I am now chair of this subcommittee, that I have to back up and clean my slate and start anew. I feel that responsibility. That responsibility is also very much enhanced by Vice President Gore's very strong feelings about the Space Station. He and I have talked about this, and I have committed to him, since he is Vice President and will be advising the President on these matters, that I will not only back up but clean the slate, so to speak, in my own mind, and have a completely open mind in relooking entirely at this process.

I want to say that at the beginning just to get that on the record.

We welcome your testimony, sir.

STATEMENT OF DANIEL S. GOLDIN, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION; ACCOMPANIED BY GARY ALLISON, ACTING COMPTROLLER

Mr. GOLDIN. Thank you, Mr. Chairman.

Before I give my testimony, or summarize it, I would just like to say I am in agreement with what you said. Your comment about tough love is a vernacular, but I think it is appropriate. We believe in that at NASA ourselves. And as you will hear in my testimony, and I have copies of the reforms we are proposing, NASA is proposing to take some tough love on itself, and you will see that we have a process set up where we will review programs that are in trouble and come forward and recommend to the Congress termination, if appropriate, rather than letting things go on and on and on.

I was at a hearing that the House Appropriations Committee had, where we had to discuss a GAO report, where NASA had 29 programs, with an average cost growth of 75 percent. This is not where NASA wants to go. We believe in responsible performance, so we are in agreement on that.

We are also in agreement in open communications, and we welcome that. We want to speak in straight English. We do not want to go in circles. We want to know exactly where we stand. We want to be relevant to the American public and we want to be responsive to the Congress. So, we are in agreement on that. And I am pleased about your open mind, because we believe that not only is the Space Station, but we have a holistic program that we are proposing here that addresses a balanced set of objectives for NASA that we believe meets the President's objectives.

With that, let me say we are pleased to present our 1994 budget. It is a 5-year plan. It is a very aggressive plan. And it represents a change from where we were. Just about a year ago I was in this committee room for my confirmation hearing, and this committee

challenged NASA, because the GAO report had just come out. And that GAO report had indicated that the growth in the NASA budget was projected to be between $13 and $21 billion too much.

As you will see in this budget, we have proposed a $15 billion cut in the projected growth of the NASA budget. We believe this is responsive and responsible. Averaged out over the 5-year planning period, this budget is less than the inflationary growth. It also is very, very aggressive in cutting edge technology. It is aggressive in pushing the boundaries of the NASA mission. It is aggressive in its connectivity to America in all sectors. And it is also responsive in paying as we go, because we intend to transfer the very valuable technology that we have into the American industrial base and into American competitiveness.

So, it is a very well rounded program.

I would like to call your attention to our testimony, if I might, to the first page. It is the page that has a chart like this. It is an attachment to the testimony, and it shows the 1993 NASA plan as it was submitted a year ago today, extended out over the 5-year period. And we have taken $23.8 billion out of that projected growth, and then added back $8 billion in what we believe is aggressive new content that is much more relevant to where NASA ought to go. So, we had a net reduction over that period of about $15 billion.

When you take a look at that line, it is a little less than the 3-percent inflationary growth projected over that time period.

If you take a look at the next chart, it indicates the areas that we have made significant cuts. And I might point out here that we have been tasked by the President to take a look at scaling back on the Space Station not just to take away from the Space Station, but to assure, as you indicated, that the mission is still relevant. And the President has given us a paradox. He has asked us to cut the Space Station costs both development and operation, while at the same time giving us equal or better science and technology.

This has been done in the past and this can be done, and we believe we can do it. In this particular table, we picked a nominal financial target that the White House has given us. They have asked us to look at three designs, a $5, a $7, and a $9 billion design. For the nominal $7 billion design, you see over the 5-year planning period there is an $8 billion reduction in the Space Station. We are proposing a $3.4 billion reduction in the space shuttle development and operations.

We are doing this because we believe it is the right thing. We believe we will maintain equal or better safety with the shuttle. And just having tens of thousands of people gathered around the shuttle does not assure safety. The proper processes, the proper training, and the proper focus is what assures shuttle safety.

We are also proposing infrastructure reductions of $2.8 billion. The largest portion comes out of the space communications budget, and we are proposing cancellation of the TDRSS II or the TDRSS follow-on activity, and going with a interim solution of functional equivalent spacecraft to replace it and a very aggressive, bold program to look at advanced technologies and new contracting approaches so that NASA could work in concert with the American space communications industry and come up with a much more

cost-effective and much more meaningful replacement to the TDRSS program.

We are also cutting construction of facilities $600 million and we are reducing civil service costs by $700 million. We intend to do this without an involuntary reduction in force.

As a result of some of our internal reviews, we have reduced the restructured Cassini, AXAF, and EOS programs $2.6 billion, and we believe we have stronger programs with better reserves and much higher probability of success.

We are also proposing the termination of the National Launch System and the space exploration initiative. Although we are eliminating the Space Exploration Initiative Office, the long-term human exploration of space remains a very strong focus target for NASA.

But we do not believe, at this point in time, we are ready. We do not believe we have cost-effective solutions, we do not believe we have established that humans could live and work in space for long periods of time, and we do not have a program that is short enough in duration and low enough in cost and involving our international partners, that we are yet ready to do it. However, we will maintain a low-level study activity so when we meet all those other criteria, we are ready to come forward and propose a responsible program.

And finally, we have other reductions and efficiencies at $3.5 billion for a total reduction of the 1993 budget of $23.8 billion.

If you go back to the next chart, we discuss areas where we have added significant new activities. We are adding $600 million back into the shuttle program, for improvements that will increase its safety and improvements that will cut its operating costs. We are proposing a very bold Gravity Probe–B mission, which is at Stanford University, which is fundamental physics which will validate some of Einstein's general theories of relativity.

The technology here is cutting edge, its relevance to America is outstanding, and we believe it is a program that is long overdue. For too many years NASA has been waiting for the Congress to put this back in the budget, and this year we come forward and say we want it in the budget and we strongly support it.

Most importantly, we are proposing the revival of the aeronautics technology base in this country. Over the last 25 years we have lost in excess of 25 percent market share in long-haul subsonic transports, and we have almost lost the general aviation market. We have gone down from building 18,000 planes per year in 1979 to 656 planes in 1991. We have lost almost completely the commuter market, and we must do something to cause our industry to be much more effective.

Now, NASA will be out there on the cutting edge with our industry in developing new technologies, and we are going to do this on a cost-sharing basis with the industry rather than having NASA have its traditional programs. It is crucial. This is probably one of the most important things that we are proposing, and we are prepared to talk about that in detail.

In addition, we are proposing a technology package of $8.1 billion with some bold new programs and bold new approaches for reaching out and involving the full cross section of America and, finally, the advanced solid rocket motor.

I am prepared to talk about these programs in detail. There is a summary of the $8.1 billion technology package on the next page. But most importantly, this budget represents a lot of hard work by some very dedicated employees. It represents long discussions that NASA has had with the industry. In fact, we have spent an intensive amount of time with the aeronautics industry, meeting with the CEO's, meeting with the subtier suppliers, meeting with the major aircraft companies, to establish that we had a program that was relevant and that was needed. And we have tried to do these in all areas. We have reached out and had town hall meetings across the country. We have had six meetings with standing room only and we had overflow rooms filled up.

We believe America wants a space program because they understand the importance of the program. This program is an investment we make in the future of our children, and toward that end we cannot back off, but we must be responsible and we believe we have delivered a responsible budget.

Thank you.

[The prepared statement of Mr. Goldin follows:]

PREPARED STATEMENT OF DANIEL S. GOLDIN

I am pleased to be here today to describe NASA's FY 1994 budget request for the Subcommittee. As you know, the President has submitted to the Congress a request totalling $15.265 billion for NASA. A detailed summary of this request is appended to my statement as Attachment I. This budget proposal represents a great deal of hard work by many dedicated people, and, I believe, marks a profound change in the way we propose to do business at NASA.

Fundamentally, this budget reflects NASA's acceptance of the President's challenge to produce a realistic five-year funding plan for NASA, while also making our programs more relevant to America. NASA's budget is responsive to the President's new technology initiative, "Technology for America's Economic Growth—A New Direction to Build Economic Strength." This initiative recognizes that investments in technology offer new opportunities for creating higher-wage, higher-skills jobs for more competitive businesses. The initiative also recognizes that the best way for the Federal Government to ensure its investments are commercially relevant is through cost-shared and jointly-planned technology development partnerships with industry and academia. Consistent with his initiative, the President's budget accommodates a robust plan for ongoing NASA programs, a redesigned Space Station, and a series of potential new technology activities.

I would like to begin by outlining the larger five-year budget picture which is represented in the President's request for NASA, and is displayed in Attachment II. The five-year spending plan assumed by NASA in the President's FY 1993 budget submission, projected one year, reflected a total projected NASA expenditure of $96.1 billion for FY 1994-1998. Under President Clinton's FY 1994 budget plan, NASA has eliminated a total of $23.8 billion from programs in our previous five-year spending plan. I am proud to say that nearly one-half of these reductions were identified last year by NASA's Red and Blue internal review teams in the form of program restructurings, management efficiencies, and changes in contract structure or new ways of doing business. After making a total reduction of $23.8 billion to NASA's previous plan, $8.1 billion was added in terms of new programs and new technology initiatives designed to bring increased return for America. The bottom line is that, when comparing the five-year runout of NASA's plan last year with the President's FY 1994 budget, there is a net reduction in planned NASA spending over the next five years of approximately $15 billion. At our current funding level, that is equivalent to deleting an entire year's worth of funding out of our five-year plan.

While the President's budget reflects major reductions in planned NASA spending over the five-year period, it represents an increase of $935 million above the FY 1993 appropriations level. This funding level is designed to provide adequate resources in FY 1994 for increases in ongoing programs, and to cover transition costs for whatever option the President identifies for Space Station, while allowing us to

initiate a mix of exciting new technology programs. Beyond FY 1994, NASA's budget reflects incremental annual growth for inflation.

SPACE STATION REDESIGN/TECHNOLOGY INVESTMENTS

Fundamental to the success of the President's FY 1994 budget plan for NASA is the redesign of the Space Station. The previously planned Space Station Freedom program is unaffordable in light of total constraints on NASA's budget, funding needs of other NASA programs, recent Station cost growth, and the President's direction that NASA invest in new technology projects that can contribute sooner and more directly to the U.S. economy and technological/scientific goals. The President has directed NASA to redesign the Space Station so as to substantially reduce development, operations and utilization costs while maintaining early capability to conduct high priority scientific and technological research. The redesign of the Station will enable a rebalancing of priorities across the Agency, to permit increased investment in a variety of science, space and aeronautical research and technologies which will be accomplished more rapidly and made available to a broad spectrum of U.S. industry.

NASA's role in the redesign effort is to be "an honest broker," to set up a process to develop a range of possible options and work with a Blue Ribbon Panel of experts which will assess and establish the advantages and disadvantages of each option as an input to the Administration where a final decision will be made. Our charter for the Station redesign effort stipulates that we:

- develop options which result in a program that is more efficient and effective and capable of producing greater returns on investment;
- significantly reduce development, operations and utilization costs while achieving many of the current goals for long-duration scientific research;
- consider all phases of the program design, assembly, operations, utilization and management of the Space Station;
- for all program options, utilize, as much as feasible, the efforts to date of the Space Station Freedom program;
- address options for achieving earlier research results prior to Space Station availability; and,
- develop redesign options which continue to accommodate and encourage international participation.

Mr. Chairman, we are resolved that the redesigned Space Station be a useful, vital laboratory for the conduct of meaningful research. Toward this end, we have worked closely with the user community, our international partners, and such independent advisors as the National Academy of Sciences, the National Research Council, Space Science and Applications Advisory Committee and its Space Station Science and Applications Advisory Subcommittee, the Aerospace Medicine Advisory Committee, tne Task Group on Utilization and Operations, the Space Systems and Technology Advisory Committee, and the Centers for the Commercial Development of Space. Together, we are working to identify the high-priority microgravity objectives of the materials and life sciences disciplines, and the design requirements necessary to meet their requirements. Accordingly, the Space Station redesign will provide power, volume, microgravity environment, data and communications consistent with user requirements.

Three cost options for the Station redesign have been identified for the five-year period from FY 1994 through FY 1998: $5 billion, $7 billion, and $9 billion. These funding levels would include development, utilization, shuttle integration, facilities, research operations support, transition costs, and augmented early flight research. NASA's Station Redesign Team is scheduled to report on a range of detailed options to the President's Advisory Committee on the Redesign of the Space Station on June 7. The Advisory Committee plans to make recommendations on each of the options to the White House on June 10.

Most importantly, the redesign of the Space Station will allow implementation of a far-reaching New Technology Investment package which could reinvigorate our industrial base and enhance America's competitiveness in the global marketplace. The combined Space Station/Technology Investment wedge is identified in the President's budget at a constant $2.3 billion level throughout the funding period. The elements of the Technology Investment package will emphasize focused, innovative approaches to push technology development, tied to the Administration's funding determination for the redesigned Space Station. A budget amendment outlining spending levels and program plans for the redesigned Space Station and the spectrum of technology initiatives is planned to be submitted to the Congress in June, following completion of the Space Station redesign activities.

REDUCTIONS REFLECTED IN FY 1994 REQUEST

Let me now describe for the Committee the specific reductions reflected in the President's budget. These items are outlined in Attachment III.

While the Administration has not yet made a decision on a specific funding level for Station, we are evaluating technical options which would be accommodated under three alternative funding scenarios as mentioned. Cost options being considered for the redesigned Station represent reductions of $6-$10 billion over five years.

We have reduced planned Shuttle costs by $3.4 billion over the five-year period, through improved efficiency of operations, definition of work no longer required which could be eliminated, and prioritization of all work not mandatory to safely accomplish the Shuttle flight manifest. We remain fully committed to Shuttle safety and technology upgrades.

We are also targeting infrastructure costs for reduction. Under space communications, we have canceled TDRS-II, and will instead procure spacecraft functionally equivalent to the existing design as an interim solution to NASA's pressing tracking needs. This will give NASA time to carefully review future requirements and develop, with industry, a new generation of spacecraft using innovative technologies which will lower costs and further the capabilities of the space communications industry. At the same time, our goal will be to reduce planned Construction of Facilities funds by $.6 billion, and our NASA workforce costs by $.7 billion, with the latter to be achieved through means other than involuntary reductions-in-force.

We have identified significant additional savings through restructuring of the Cassini probe to Saturn, the Advanced X-Ray Astrophysics Facility (AXAF), and the Earth Observing System (EOS). Cassini has been rescoped to meet a smaller level of funding this year, and smaller total runout cost, while preserving its major science objectives and the October 1997 launch date. The AXAF mission now includes two spacecraft, the result of a redesign that saved $300 million. The first spacecraft, AXAF-I, will be launched on either the Space Shuttle or a Titan IV in FY 1998. The second spacecraft, AXAF-S, will be launched on a medium-class expendable launch vehicle in calendar year 1999. This change plays to certain design strengths and will end up saving the taxpayers money while preserving the essential science goals of AAAF. The EOS redesign has saved $2 billion over the five-year period. This reduction was accomplished without delaying the June 1998 initial EOS-AM-1 launch readiness date, and by maintaining the essence of planned instrument complements and science.

This budget also terminates effort on the National Launch System while we pause to explore all possibilities for new space transportation technologies which will enable the United States to lead the industry, not just reach parity several years behind our international partners. We also have terminated the Space Exploration Initiative in recognition of the near-term limits to our resources and other priorities. However, we have not abandoned our intent to go back to the Moon and to push on to Mars; in fact, this budget preserves options to develop small lunar orbiters which could carry out the first post-Apollo scientific discovery flights to the Moon.

Finally, we have identified other efficiencies and reductions over the five-year period for a total of $3.5 billion saved from the previous plan. These include cancellation of the space nuclear power program and Government-wide reductions in administrative costs.

NEW CONTENT ADDBACKS IN THE FY 1994 BUDGET

Let me now turn to the items we added to the budget following the reductions. These are displayed in Attachment IV.

While we have made major reductions in planned Shuttle costs through efficiencies achieved over the planning period, we remain committed to Shuttle safety and technology upgrades. The budget reflects continued investment in a more reliable Space Shuttle Main Engine as well as avionics upgrades. It also includes investment in the technology for a 30-day Long Duration Orbiter and finances missions to Russia's MIR Space Station including an astronaut visit in 1994 and a shuttle mission in 1995.

Secondly, we have included initial funds for Gravity Probe-B, an extremely technically challenging fundamental physics experiment to verify Einstein's theories of relativity.

The major third category is new technology investments, including augmentations to our aeronautical program. NASA's aeronautics program is critical to the future of an American industry that involves one million jobs. This is an important phase in a significant upgrade of NASA's aeronautical capability. Our budget request will support four major areas of improvement in the aeronautics program:

• high-speed research leading to industry development of an environmentally acceptable and economically sound American supersonic transport;
• new technologies for subsonic long-haul aircraft, general aviation and commuter aircraft, and investments in the new and expanding field of remotely piloted vehicles;
• major upgrades to our national aeronautical facilities; and,
• continued investments in a restructured joint NASA/DOD hypersonic research program to develop and demonstrate technology required to permit the Nation to develop reusable, single-stage-to-orbit vehicles with airbreathing primary propulsion as well as horizontal takeoff and landing.

This budget marks the largest increase in aeronautics funding in decades. Overall, NASA's aeronautics R&D program is increased by 17.9 percent in FY 1994; by FY 1998, the cumulative increase will be more than 55 percent. If additional funding is identified for even more aggressive wind tunnel revitalization, that level of growth may be even greater.

This request accommodates continued funding for the Advanced Solid Rocket Motor, which was restored by the Congress in FY 1993. Consistent with overall NASA funding constraints, the ASRM schedule has been further adjusted to match funding availability in FY 1994 and future years. The ASRM will improve system safety and reliability of the Shuttle while increasing payload lift capability.

The elements within the President's Technology Investment package will emphasize focused, innovative approaches to push the horizons of American technology. A listing of potential investments in this proposal are displayed in Attachment V. Some examples of new projects that could be proposed include:

• *Technology Research Institutes*—These institutes would be consortia combining the talents of NASA, the aerospace industry and universities. Through the institutes, industry and academia would gain access to the NASA centers, with the goal of developing dual-use technologies, and finding ways to push the early application and commercial use of new products and techniques. Graduate students would study at the institutes, and undergraduates would work alongside aerospace professionals.
• *Automation and Robotics*—Two key areas in the technology of tomorrow are automation and advanced robotics. Many of the most promising technologies of the future will come from our work to improve our automated and robotic capabilities for Earth observation satellites, deep space probes and astronomical observatories. Automated rendezvous and docking programs could reduce the cost for resupply of the Space Station. Efforts being considered include cooperative demonstration flights with the Russian and European space programs.
• *Small Spacecraft Technology and Applications*—this initiative would focus on pushing ultra-light, low-cost satellite and instrument technology through both novel data purchase and more traditional flight demonstrations. Small spacecraft technology has evolved significantly over the past several years. It appears that science missions using these technologies may now be developed and launched in less than two years and at significantly reduced cost. These technologies could be pushed through user-defined and competitively-selected data purchase partnerships involving the government, researchers, and industry. The government would pay for only its technology contributions if the data was not delivered. Several missions could be done each year providing useful science data and extensive training opportunities for the next generation of scientists and engineers. In addition, some portion of the funding would be used to further push this technology through joint NASA-industry technology flight demonstrations.
• *Aeronautics Technology Augmentation*—As previously mentioned, NASA would push aeronautical technology in the areas of high-speed flight research, subsonic, hypersonic testing and revitalization of the national aeronautical facilities.
• *New Small Earth Probes and Global Monitoring*—This program could be a direct beneficiary of the small spacecraft technology program. There are many gaps in the data scientists need to accurately assess the extent and impact of global climate change. These small Earth probes could be used to fill those gaps, searching for specific strands of information to fill the larger data base, and complementing the planned system of larger Earth Observing System science platforms. These missions could involve creative cooperative arrangements, including data purchase arrangements with industry and universities.
• *New Small Deep Space Probes for Science and Exploration*—This initiative would provide increased opportunities for universities and industry to participate in NASA's planetary exploration program. Under consideration is a new class of small, low-cost "Discovery" missions similar to the "Explorer" class missions in physics and astronomy. The Discovery probes would feature highly focused science objectives with a small complement of instruments, strict cost caps, short development times and the use of small launch vehicles.

• *Science Research and Analysis*—Increased funding in this area would enable improved analysis and distribution of data from ongoing science missions. This program could expand the involvement of women and minorities in NASA's scientific enterprise, while enhancing the scientific capabilities of the nations universities in Earth and space science.

Depending on the balance between the redesigned Space Station and the tech packages, we may be able to start as many as four new series of small spacecraft in FY 1994. For example, we could possibly move ahead with the Discovery program, the advanced Earth probes, tech-sats and lunar probes. The base program provides for starting a variety of other spacecraft during the five-year period.

• *Advanced Launch Technology*—The U.S. will continue to pursue lower cost access to space. This initiative could be conducted on a cost-sharing basis with other agencies and with industry to enhance propulsion, develop lower-cost engines, and investigate new approaches such as hybrid rockets and other low cost propulsion systems.

• *Expendable Launch Vehicle Improvements*—NASA is considering funding contractor-managed upgrades to expendable launch vehicle technology using novel contracting approaches.

SUMMARY

Taken together, these initiatives and the new funding trends we are announcing today represent a sea change for NASA's programs. We expect to provide opportunities to expand the participation of minority- and women-owned businesses, academic institutions of all sizes, and entrepreneurial enterprises to work with NASA toward concentrating on demanding missions that utilize innovative technology that can, in turn, be applied on Earth to energize our industrial base.

We held a series of town meetings all over the country this past year to seek the wise counsel of the American people. NASA plans to hold another series of meetings which will gather views on implementation of the President's new technology projects from a wide variety of voices across the Nation. We will invite representatives from a broad spectrum of the business and academic communities to share their ideas on how to make new NASA projects more relevant to the American people. The success of forging new partnerships depends on improving communications. These meetings will provide a continuing dialogue with academia, industry, and technology communities and groups that will receive the greatest benefit from the new initiatives.

We have already begun a process of change within the NASA institution. Nearly one year ago, we initiated an intensive internal Agency review involving "Red and Blue" teams and institutional teams to examine all our programs and the manner in which we conduct our business. These reviews were a unique opportunity to undertake an important, critical self-evaluation. The teams focused on identifying requirements which could be eliminated, efficiencies which could be incorporated, and ways in which NASA's programs could be made better, faster, and cheaper. As I mentioned earlier, their efforts identified savings for NASA in excess of $10 billion over five years. A special team assessed current procedures for planning and initiating programs within the Agency, and have undertaken improvements which will result in reduced cost and technical risk on new and future NASA aeronautics and space flight programs. Institutional teams also identified a number of weaknesses in existing program management and procurement practices which have contributed to past cost growth in NASA programs, and which formed the basis for a series of broad management and procurement reforms upon which NASA has recently embarked, which, I am confident, will put NASA solidly back on track.

We intend to continue to ensure that, as a cutting-edge institution, diversity is at the root of our workforce, and to enhance that workforce by inviting greater participation of minorities, women and the disabled. And we intend to continue to make progress in expanding the percentage of our annual contracted effort which is conducted by small disadvantaged businesses, with great hopes of reaching our projected goal of 8 percent in FY 1994.

I believe this budget address America's long-term interests in civil space and aeronautics. It is a fair budget, and if we execute it properly, we should have a more balanced program in the future. We will be able to make some of the critical investments this country requires to push its technology forward into the 21st Century. In the process, I believe we will make the overall NASA program a much healthier enterprise.

By early in the next century, we could have a new fleet of small capable spacecraft exploring the solar system, while advanced hypersonic, supersonic and subsonic aircraft in development will be revitalizing America's aeronautical base and

67-115 O - 93 - 2

our access to space. We could have a new stable of low-cost, ultra-reliable expendable launch vehicles to further augment our ability to get this new array of scientific payloads into space. We could have a productive Space Station opening new frontiers from its vantage point in low-Earth orbit. We could have a much healthier, balanced set of programs that make a difference to America.

For the past 35 years, NASA has been a source of wonder and hope for the future to America and the world. NASA must be successful in addressing the financial and technological challenges facing us today so that we can continue to inspire young and old alike, help rekindle the American spirit, and -rejuvenate the economy. If we can make these contributions represented by the President's budget for NASA today, I believe we will help this Nation reap rich benefits from our science and technology investments tomorrow.

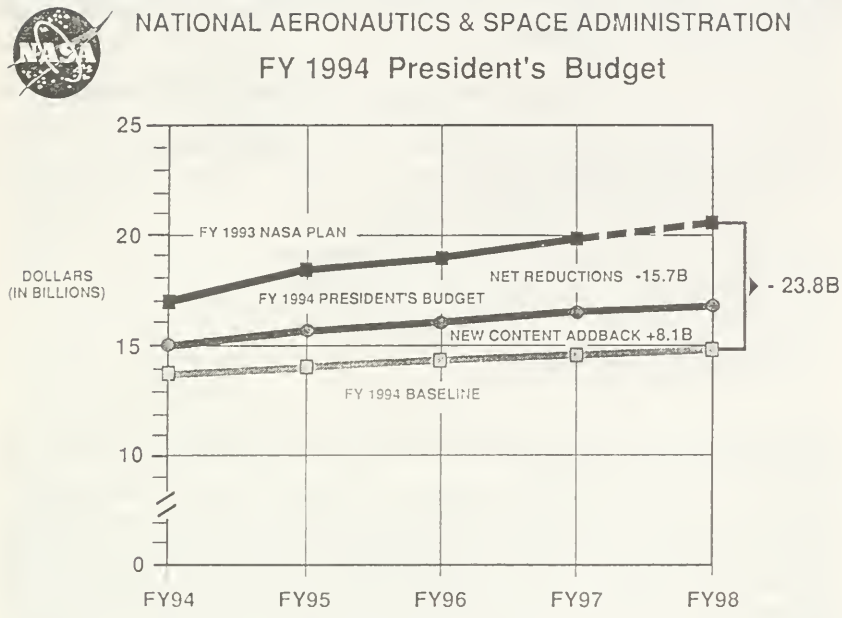
Thank you very much, Mr. Chairman, for this opportunity to describe the President's FY 1994 budget proposal for NASA. I would be pleased to respond to any questions you may have.

ATTACHMENT I—National Aeronautics and Space Administration Fiscal Year 1994 Budget Summary

[In millions of dollars]

	Budget plan		
	1992	1993	1994
Research and development	**$6,827.6**	**$7,089.3**	**$7,712.3**
Space station and new technology investments	2,002.8	2,122.5	2,300.0
Space transportation capability development	739.7	649.2	649.2
Physics and astronomy	1,036.7	1,103.8	1,074.7
Planetary exploration	534.2	473.7	557.2
Life sciences	157.6	140.5	.....
Life and microgravity sciences and applications	.....	.....	351.0
Space applications	985.1	1,148.0	.....
Mission to planet Earth	.....	1,074.9	
Space research and technology	309.2	272.7	298.2
Commercial programs	147.6	164.4	172.0
Aeronautical research and technology	788.2	865.6	1,020.7
Transatmospheric research and technology	4.1	.....	80.0
Safety, reliability and quality assurance	33.6	32.7	35.3
Academic programs	66.8	92.9	74.5
Trucking and data advanced systems	22.0	23.3	24.6
Space flight, control and data communications	**5,384.8**	**5,086.0**	**5,316.9**
Shuttle production and operational capability	1,296.4	1,053.0	1,189.6
Shuttle operations	3,029.3	3,016.0	3,006.5
Launch services	155.8	180.8	300.3
Space and ground networks, communications and data systems	903.3	836.2	820.5
Construction of facilities	**531.4**	525.0	545.3
Research and program management	**1,575.8**	**1,615.0**	**1,675.0**
Inspector General	**13.9**	**15.1**	**15.5**
Total budget authority	**14,333.5**	**14,330.4**	**15,265.0**
Outlays	13,959.9	14,077.6	14,670.0

ATTACHMENT II



ATTACHMENT III—Fiscal Year 1994 President's Budget—Five-Year Summary—Reductions

[Fiscal years 1994–98—In billions of dollars]

	Fiscal year 1993 budget runout	Fiscal year 1994 budget runout	Delta
Space station	$15.1	[1] $7.1	$—8.0
Shuttle	22.8	19.4	—3.4
Infrastructure reductions	18.5	15.7	—2.8
Space communications	6.8	5.3	—1.5
Construction of facilities	2.2	1.6	—0.6
Civil Service costs	9.5	8.8	—0.7
Restructure	10.7	8.1	—2.6
Cassini	1.7	1.4	—0.3
AXAF	1.9	1.6	—0.3
EOS	7.1	5.1	—2.0
Terminate NLS	3.0	.....	—3.0
Terminate SEI	0.5	.....	—0.5
Other efficiencies and reductions	25.5	22.0	—3.5
Total	96.1	72.3	—23.8

[1] The Administration has not made a decision on the funding level for the Space Station. Three budget options are being examined and the exact funding level is dependent on the outcome of the Space Station redesign effort.

ATTACHMENT IV—FY 1994 PRESIDENT'S BUDGET—NEW CONTENT ADDBACK

- Shuttle Improvements
- Gravity Probe–B
- Aeronautics

- New Technology Investment Candidates (Specific projects have not been identified. Total funding and content are dependent on administration decisions after the Space Station redesign effort is completed.) (Includes Aeronautics Augmentations)
- Advanced Solid Rocket Motor

ATTACHMENT V—FY 1994 PRESIDENT'S BUDGET—NEW TECHNOLOGY INVESTMENT CANDIDATES

- Space and Aeronautics Technology Development and Flight Programs
  - —Technology Research Institutes
  - —Automation and Robotics Technology
  - —Small Spacecraft Technology and Applications
  - —Aeronautics Technology Augmentation
- Scientific Earth Satellites and Deep Space Programs
  - —New Small Earth Probes and Global Monitoring
  - —New Small Deep Space Probes for Science and Exploration
  - —Science Research and Analysis Augmentation
- Launch Vehicle Advancement Programs
  - —Advanced Launch Systems
  - —Expendable Launch Vehicle Improvements

[NASA Management and Procurement Reforms—April 1993 may be found in the committee files.]

Senator ROCKEFELLER. Thank you very much, Mr. Goldin. I think you deserve, and the administration does, a lot of credit for trying to gain control of the NASA budget. As I said in my earlier statement, I think we in Congress share some of the problems in the past, sort of jump starting and stopping and, you know, sudden preference to this and then pulling away. It has been very disconcerting for the NASA professionals, I am sure.

But it is difficult to look at these reductions, for example—and, you know, they are big reductions, Space Station, shuttle, et cetera, almost $24 billion from last year. And you say with great sort of conviction and strength, almost like we are adding on $23 billion rather than subtracting it, which is good because it clearly shows that you believe this can be done.

I guess what I want to as my very first and hopefully symbolically first question, is to say, as opposed to just cutting dollars and looking at units of savings and efficiencies, to talk about, at the beginning, the mission and the vision that you would have both in terms of space and in terms of aeronautics. In other words, it is not just the number of programs that are contemplated in this sheet here, but what the meaning of it is.

And that can be taken as sort of a naive question, but I think it goes with your town meetings. If people believe, it is because they believe there is a reason out there, and I would like to get your sense of the mission and the purpose in space and aeronautics.

Mr. GOLDIN. I think the basic reason for NASA to exist is that aeronautics and space provide tangible benefits to the future of our country. And that NASA is an investment that we make in our future, to gain new knowledge that would not come in from the industrial base in this country with regards to our environment and the understanding of our universe, to better understand how to have more productive lives here on this planet.

I think that is the overriding reason for NASA. Because we do that, we perform missions that are incredibly difficult. These mis-

sions cause us to go to the cutting edge. You cannot send a spacecraft halfway to Mars and say it is successful. You have to get down to Mars, you have to land, you have to have rovers go over the surface, collect data, understand the weather, and have a communication system to get the data back to Earth. If one were to merely go into the laboratory and say I am going to develop technology and I will just stop at some point and produce that technology, you do not have the degree of difficulty that we have with these bold missions, which gets me to the second point for NASA's existence.

While we are doing very important missions, important to our society in space, we are able to bring back relevance to our country and create new economic opportunities. We create new industries as a space-faring society. The whole space communications industry came out of NASA. An embryonic industry is building right now in remote sensing: that will come out of NASA. Weather forecasting comes out of NASA.

The third leg of NASA's importance and relevance to the country is because we work on difficult missions, we develop technologies that normally otherwise would not be available to the American public. And these technologies constantly fall out. And if we learned one thing at our town hall meetings, the people told us NASA, we love the space program, we understand the space program, but you have not communicated it very well. And that was the single biggest learning we had at the town hall meetings.

So, we have to do a better job at that. But in terms of investing in America and the relevance of our technology, we do wonderful things. And I want to give you one example, because this brings into focus what NASA is about. Because we send humans into space, we had to develop a remote sensing technique so that physicians on the ground could determine the astronauts' health. The only way to determine astronauts' health is to peer into their eyes; that is the only place you can see blood vessels, by looking into the eyes.

We developed a system so we could determine fluid shifts in the body. As a result of that cutting edge work, we have a program going on right now with the Center for Commercial Development of Space, where we are sending a van into the Southwest United States where we are going to do prescreening on diabetes and hypertension on people in rural areas that normally would not be able to get that type of medical attention. And that data will be telemetered back through a satellite link to a hospital where a physician can do that prescreening. This is the type of technology that NASA develops and turns into the economy, and in this program we are proposing, we have tremendous relevance to building economic strength in this country.

In addition to those characteristics we also provide educational opportunities, we provide hope that our children will have a much better environment because we will understand our planet's environment and relate the environment on other planets in our solar system back to Planet Earth. There is a greenhouse effect on Venus, there was a loss of atmosphere on Mars, and we are understanding the processes on the Sun and how it couples into our own atmosphere. All these things are relevant.

And the final point I want to make is aeronautics is the first A in NASA, and aeronautics is a competitiveness activity and NASA intends to work with our aeronautics industry to protect those 1 million jobs and build the highest technology-based industry in this country, if not the world, so that it is stable and contributes not only to NASA, but to the world's economy.

Senator ROCKEFELLER. Mr. Goldin, thank you. I want to pursue that a bit, but I violated my first rule on my first opportunity. After having said so many good things about Senator Burns of Montana, I totally ignored when he came in and sat down beside me. The first rule of protocol is that you recognize your ranking member if you wish to succeed in this subcommittee.

And I apologize to you, Senator. I welcome any comments you might have about any subject.

OPENING STATEMENT OF SENATOR BURNS

Senator BURNS. Well, thank you, Mr. Chairman. I appreciate you having this hearing today.

And Mr. Goldin, it is nice to see you. I cannot believe that we are having a greenhouse effect on a planet where we Americans are not there to create it. I find that hard to believe, from what I have read and everything.

Thank you, Mr. Chairman. We worked really well on the other committees on this, as on other subjects, and I am looking forward to this one because not only am I involved here on the committee of jurisdiction but I am also on the Appropriations Committee of the same. So, it is going to be kind of an exciting 2 years, I think anyway, as far as the space program as we look at our technologies and our sciences.

And I want to congratulate you, Mr. Goldin. I have been following along and reading and you are trying to change an agency and change direction because our whole mission has been—since Mr. Kennedy said we are going to beat the Russians to the Moon and we did that, now we have to change a little bit. Refocus, in other words, and retool, especially in an agency that has been reluctant for change.

And so I congratulate you on that and what you are trying to do. NASA's $15.3 billion request is a legitimate attempt, I think, to bring the cost of our space program under control, and it refrains from proposing any new starts and concentrates instead on providing full funding for current programs so that they remain on schedule and within budget.

If there has been one organization in this Government that has always come in, asked for funds on specific programs under what they thought they would need and then later on for the overruns and everything else would come back and rerequest, it is NASA, but you are setting a new direction as far as this agency is concerned, so I congratulate you on that.

I would ask that my statement just be put in the record. I just want to sit and listen. And I want to congratulate our chairman too, because I think for the first time we are going to sit down, take a look at the competitiveness issue. And when we talk about space and we talk about these programs we like to think sure, that the American people do derive economic benefit from them.

But I think the most important—what could be the most important thing that is often not talked about, and I do not think it is overlooked, we just do not talk about it—is man grows with these programs. Man is naturally curious and the day we quit growing and our curiosity sort of turns dormant is a day that this society called man will fade from the face of the Earth.

So, we do not want to base everything on economic return to a society. I think this is what makes us exciting as people as an American society, is this natural curiosity. And I think you have kind of brought that back to the agency, and I would hope that we could probably tell our young people in our schools—my daughter will graduate from Montana State University this spring. She has just been accepted to the University of Washington Medical School, I am very proud of her. She is my supercool chick, I call her, and I will die poor getting this kid educated. But she said do not worry about it, Dad, you will die healthy because I will take care of you. [Laughter.]

But it is the natural curiosity of people to think and to move this society forward that is really the big payoff to the American society. So, I appreciate that.

And thank you, Mr. Chairman, for your leadership on this. And I want to tell my good friend over to your left that I did get out of Las Vegas at the National Association of Broadcasters with every nickel I took in there.

[The prepared statement of Senator Burns follows:]

PREPARED STATEMENT OF SENATOR BURNS

Thank you Mr. Chairman, for holding this important hearing on NASA's budget request for fy94. In addition to working with you on this subcommittee, as a new member of the Appropriations subcommittee with jurisdiction in this matter, I take a double interest in hearing what NASA has to say. I also want to welcome Dan Goldin to the Science Subcommittee. From what I hear, you have one of the toughest jobs in government and are to be congratulated for attempting to institute change in an organization that has, in the past, been resistant to change.

In past years, NASA has come to us with unrealistically low cost estimates for new programs. When costs ballooned, NASA would then ask Congress for more money, or, if that didn't work, NASA would delay or scale down the program. My sense is that you are committed to changing that way of doing business.

NASA's $15.3 billion request is a legitimate attempt to bring the costs of our space program under control. It refrains from proposing any new starts and concentrates instead on providing full funding for current programs so they remain on schedule and within budget.

Mr. Chairman, while the specific budget request is important, the larger question is what is NASA's role going to be in these changing times. Years ago our space program was driven by the single goal of beating the Russians to the moon. Times have changed. The battlefield is now the global marketplace. I think we need to start exploring how to use NASA's vast resources and talent to enhance U.S. competitiveness, particularly in areas such as aeronautics, computers, and communications.

Mr. Chairman, I am a big supporter of the High Performance Computing and Communications initiative and, in fact, I have cosponsored legislation to expand that program. That is why I am pleased that NASA has allocated $65 million for NASA's part of that initiative. I believe the computer initiative has the potential to revolutionize how we live and work. I am particularly excited about how it may advance our communications technologies and permit widespread telecommuting where people are able to perform their jobs at their home computers.

Finally, Mr. Chairman, I am pleased that the budget request calls for an 18 percent increase in aeronautics research and includes money for the National Aerospace Plane (NASP). A space plane that can vault into orbit from a conventional runway can have enormous benefits for civil aviation, the space program, and our national security.

Thank you again, Mr. Chairman, and I look forward to hearing from Mr. Goldin.

Senator BRYAN. If I might be permitted to respond, if you look at the definition of "to lose" in Webster, it tells you not to know where something has gone. In Las Vegas you will always where your money has gone. [Laughter.]

Senator BURNS. Thank you, Mr. Chairman.

Senator ROCKEFELLER. Thank you, Senator Burns. I want to pursue a little bit the cutback envisioned and mission and how those all work together in more confined financial and spiritual space, so to speak, but let me yield, first, to the Senator from Nevada.

Senator BRYAN. Mr. Chairman, thank you, very much.

Mr. Goldin, I observed at the outset that your budget, like all the budgets we deal with, is a matter of priorities, a lot of things like we would like to do. I suppose one could say as an abstraction that all research has some potential in terms of developing a new fund of knowledge which may lead to some improvement in terms of advancing our civilization. But the one program here that I have had some difficulty with in terms of justifying since I have been in the Congress, and I want to ask you a couple of questions about that, and that is in terms of setting our priorities. I take it that you had a series of town hall meetings. Can you tell me just a little bit about the format and what you hoped to get out of those town hall meetings, without going into all the details?

Mr. GOLDIN. Sure. It was an experiment, because we wanted to do a better job of communicating with and listening to the American public, because they are our customer. And we had to get reconnected, especially with the change in objectives for the agency. So, we set up meetings in six cities. I will try and recollect them: Tampa; Hartford; Indianapolis; Seattle; Compton, CA; and one more—I cannot remember the other one.

We went into each city, we sent notices out in advance, and we asked people what were you interested in. We had about overall 4,000 people attend these meetings. We tried to hold them at universities. We started the day off by going to elementary and middle schools to understand what the children thought, what their parents thought.

We met with members of the small business community, the minority business community, and then we met with members of the aerospace community in each city. In some cities we did not have aerospace community so we met with the industrial base in those cities. For example, in Indianapolis, I went to Eli Lilly to talk to them about what they thought the relevance of the space program was to them.

And then, we would end the day with a town hall meeting attended by 500 to 800 people, 1,000 people in one circumstance, and I would open up the session and talk about the NASA vision, summarize the programs, and then we would open it up to questions and answers. I would give questions and answers for 45 minutes, and we brought a NASA panel of leaders up to the platform and we would go for another 2 hours. That was the format.

What did we find? We thought that there would be a bias in the data or randomness in the data as we went across the country. There was a uniform distribution. People wanted humans in space, they wanted robots in space, they were interested in aeronautics,

they were interested in technology, and our sampling said that there was a broad base of support for a variety of the NASA programs. We did not see any peaks or valleys.

We found that people had the biggest concern that we at NASA were not doing a good job in communicating what it was that we did and what the results were that we were getting, that the results were going into scientific journals, but we were not reducing it into plain terms that the American citizens could understand in a broader context. They felt we were not reaching out enough in our educational programs. And they wanted to understand the relevancy of some of the data. In a number of cities we went to with high unemployment rates, they wanted to understand how NASA technology was helping the technology base of the country.

Senator BRYAN. Well, let me just say, Mr. Goldin, those of us in the Congress, imperfect as we are, also have town hall meetings to try to get a feeling on the public pulse to sound them out. I must tell you that the one program that I personally—it is not a large amount of money, admittedly, but you are asking for $12.3 million for what was once the SETI program, the search for extraterrestrial intelligence.

As you know, the authorizing committees in both Houses of the Congress last year specifically directed that it be deleted. The House Appropriations Committee deleted it. But it got put into the budget by the Senate Appropriations Committee, and it is now cast in a new name, the High Resolution Microwave Survey. I must say, without protracting this discussion, that is one program that fails to pass the smell test in terms of top priority.

You have been talking about the need to be more competitive with respect to aeronautics. I happen to agree. And there are a host of other things, I think, on which we would agree, but that is a particular program that seems to me tends to say about the Federal Government generally, all of us, is that, you know, you folks just do not have your priorities together. That would provide, in Nevada, tuition for 10,000 students, would build over 100 new homes. I mean, there are so many other things that it seems to me one could argue in terms of the priority.

But let me ask about the Space Station now, in terms of its reconfiguration. Help me to understand what its mission is, as you understand it. I realize that you are working on the $5, the $7, and the $9 billion options—what we are looking at down the road, say a decade, in terms of capital outlay for the construction and the deployment, I guess, and then what the operational costs are going to be, at least as you see it from this vantage point?

Mr. GOLDIN. Let me start with the last question and I will work backward. The operational costs of the Space Station were projected to be $2 billion a year. And we really did not have a good boundary on that in terms of is that a good number, could it go up or down? We understand, sometimes with precision, what is going to happen in the next year, but we really did not understand the out-year costs on the Space Station, and people have made a variety of estimates on the operational costs over a 30-year period, and those estimates range between $60 and $120 billion.

Senator BRYAN. Just operational cost?

Mr. GOLDIN. Yes. So, we felt that was the first place that we had to address the issue, and toward that end we set an objective of cutting the yearly projection to no more than $1 billion and to have an understanding of what those costs were and put proper reserves into it so we did not have $1 billion becoming $2 billion becoming $3 billion.

If you will recollect, the shuttle was projected to have a very low operational cost, but we put our focus on the development, and then once we had operations and already had the program there was very little we could do. So, our first priority in that Space Station redesign is to address the operational costs.

Our international partners had meetings with us on numerous occasions, and they had expressed great concern about the operational costs, as stated, but the bigger concern that I had is the depth of knowledge we had in projecting those costs. So, you have to have a very clear operational concept before you go costing it out. And that is what the team is doing.

We also said that the program was committed to be 30 years long, and that was committing this Nation to a very, very long-term activity before we really got the results back on what it was that we were doing. So, the President's guidance to NASA was to establish a 10-year program for the Space Station and perform a technical and scientific peer review at the 10-year point to see if we should continue going on with it and establish it another 5 years at that point in time rather than making an up-front 30-year commitment to the station, $1 billion commitment to the station, 30-year commitment to the station.

Senator BRYAN. Let me make sure I understand. Are we saying now that with respect to the operational costs, the projection is for $1 billion a year?

Mr. GOLDIN. That is the target.

Senator BRYAN. That is the target, and that would be for that 10-year window before the review?

Mr. GOLDIN. Yes.

Senator BRYAN. What are we projecting now for the capital outlay for construction and the deployment, itself, if you could give us some breakdown on that?

Mr. GOLDIN. We are looking at three configurations, a configuration at $5, $7, and $9 billion. By way of reference, the budget through 1998 was carrying $14.6 billion, and that is the reference point.

For each configuration, we are going to come up with the scientific and technical capabilities that go along with those budget numbers to provide for the Congress and the American public the payback for the investment. There is a very thorough process that has been set up. We are having a series of scientific and technical teams meet with various constituencies in the country to get feedback, and we are going to have a scoring system that is going to go against each one of these areas to establish what the real payback is.

Senator BRYAN. Again, so I can be clear, Mr. Goldin, so that with the $5 billion configuration, if that is the one that is ultimately adopted, we get the Space Station in whatever configuration $5 billion gives us, it is deployed, and then the operational cost in each

of the out-years would be $1 billion in that 10-year window. Then the $7 billion obviously gives us more hardware, one would presume, $9 billion, additional hardware.

Tell us, if you will, the mission and the capability that one gets for $5 billion, what we get for $7 billion, and what we get for the superdeluxe $9 billion.

Mr. GOLDIN. I would like you to withhold that question until June 7 when we report out, because I feel it would be improper to secondguess the design team. And I also would like to point out that the White House, to validate the results of the NASA design team, has asked for an independent panel made up of experts from around the country. They are going to look at each configuration and establish the advantages and disadvantages of each of the approaches so that there can be a basis for the decisions that will be made by the Congress and the White House and the American people.

Senator BRYAN. And one last question on that, then I will yield back to the chairman and hope to have a chance for a second round on some other aspect of the program. As I understand the budget request, we are talking about, for fiscal year 1994, $2.3 billion for the combined Space Station and the new technology investments. Can you tell us what portion of the $2.3 billion you are asking goes to the Space Station, recognizing that you are going to have this review at the end of June for us, but I want to know what we are getting for our $2.3 billion in terms of the Space Station piece of this budget.

Mr. GOLDIN. Well, depending upon the configuration selected, there is a variable amount of dollars available for the technology package. Clearly, at a $5 billion station you have the most money available. At a $7 billion, it is nominal, but guidance we got from the White House was, if you go above $7 billion you cannot reduce the technology package below a threshold value and NASA would have to take other cuts in its baseline budget to pay for the added cost of the Space Station. So, we would have to cancel other ongoing activities if we had a $9 billion Space Station.

Senator BRYAN. Mr. Chairman, I thank you. I will hope to have a chance for a second round. But let me yield back to you.

Senator ROCKEFELLER. Thank you, Senator.

Mr. Goldin, let me go back to where I was on the first point, and I agreed with what Senator Burns said, that there has to be a kind of a larger sense out there constantly in front of the American people. We react to challenges, we tend to be quick to believe and then quick to disbelieve, and I think our problem in NASA is to try and get a constancy, a level of constancy where we are not underexciting or overexciting.

Now, Senator Bryan was asking about the Space Station at the various levels. See, my instinct would be to start at the first level, and that is to get you to say to the American people, which is who we represent, why do we have a Space Station? What is the vision that that would mean for our people? Why do we do that? If we had one that was originally going to cost $2 billion and then went to $30 billion, and now is going to be $5, $7, or $9 billion, that is a variation of visions. Maybe it is not. But just tell me why the

country needs this, why the country supports it, what your case for it is.

Mr. GOLDIN. Let me say the first reason for a Space Station is to conduct long duration interactive human, science, and technology experiments in space, to do things that would not be normally done by the commercial sector to provide that infrastructure so that research can be done.

The research can be done in a variety of different areas. First, with regards to technology, we are a space-faring Nation, and we have to have a capability to know how humans live and work in space. We have had only one example where we have been able to bring back to Earth a long duration exposure in space. It was called LDEF, long diversion experimental facility. We found out more in that one experiment, which was a free flyer, than we have ever found in any other experience we had with regard to degradation of spacecraft from atomic oxygen, degradation of components by ultraviolet radiation. Having a permanent presence in space, it allows us to conduct technologies that are crucial to the future of our ability to be a space-faring Nation.

Second, we are able to take advantage of two conditions in space: absence of gravity and ultrahigh vacuum. If you take a look at normal manufacturing and industrial processes that have dominated our society on the ground, we have had three variables to control: temperature, pressure, and composition. By being able to go into space, we have two new variables that allow us to really get better insights into processes which take place on the ground.

There are revolutions coming in a broad range of industries—biotechnology, semiconductors—and gaining this insight is very helpful to those industries.

Senator ROCKEFELLER. Talk about what some of the implications of those revelations might be.

Mr. GOLDIN. Well, what we will do in space is understand how we could better rearrange atoms, and rearrange those atoms—and that is where fundamental research and technology is going on in the material sciences today. With the absence of gravity you do not have buoyancy, you do not have sedimentation, and as a result you do not have convection. These three processes cause problems in rearranging atoms on the ground. So, by conducting those activities in space you get a much better insight into the materials technology, into fluids both liquids and gases, and we gain insights that are not achievable on the ground, and that will feed back into the technology we have on the ground.

The third area regards the human anatomy. Every process in the human body is governed by gravity. Every system in your body is governed by gravity. In the absence of gravity the processes change in your body. On the ground we study abnormal physiology in a normal environment. That is where the lion's share of our studies go into in the medical arena. In space we take normal physiology in an abnormal environment, and as a result we get tremendous insight into the human anatomy, leading back into complementary work.

The Space Station is not going to cure world hunger, it is not going to solve cancer. But it will provide complementary data to help basic understanding of the human physiology. Right now,

there are 100,000 proteins in the human body. We have analyzed 1,000 of them. By going into space we could build better protein crystals which allow us to understand the structure of the proteins in the human body, and we get purer, larger crystals and it gives us insights not normally obtained.

We are able to do work with pharmaceutical companies to develop an understanding of viruses and proteins to develop drugs. It will not be the major share, but on the margin it provides enough capability and promise so that it is a worthwhile activity to go.

And then finally, we have to understand how humans live and work in space because we are going to be a space-faring Nation. And although now we are not ready to go do exploration of the planets because economically we are not ready, technologically we are not ready and physiologically we are not ready, the ultimate destination of people on Planet Earth is to go back to the Moon and to go on to Mars and go to near-Earth asteroids to get a better understanding of our solar system scientifically and to understand the possibility for where new resources can come from.

Senator ROCKEFELLER. When you say we are going to be a space-faring Nation, do you mean that in the scientific term, that our scientists, in the form of being in shuttles or in Space Stations, et cetera, will be doing that? Or is there an implication here that—and again, I am now talking basic vision, mission, et cetera for the future, that Americans as they used to talk about, and we have not heard that much talk recently—that the American people will, at some point in our future, be doing this? That people will be relocating?

Mr. GOLDIN. Ultimately—this is a very long way out—but an ultimate vision.

Senator ROCKEFELLER. But you have used that word a number of times. Therefore, I have to take you literally.

Mr. GOLDIN. What I believe we will do is we will crawl before we walk and we will walk before we trot and trot before we run. And initially it will be trained astronauts and trained scientists that will go into space.

This will take decades. I do not think in the decades ahead we are going to open up space to the broad population of this planet.

Senator ROCKEFELLER. We understand each other there, then. When you talk about the mission, and the vision, and the excitement of Space Station, what can happen, you indicated cancer. Is not electrophoresis—does that not take place in space, or can that take place elsewhere?

Mr. GOLDIN. Electrophoresis is a process which takes place on the ground. That is one of the things that can be studied. And with gravity it does impact the electrophoresis process. By going into space, you can get a much better defined electrophoresis process.

Senator ROCKEFELLER. So, that the cure—you do not rule out the cure for cancer.

Mr. GOLDIN. But I am not prepared to project that.

Senator ROCKEFELLER. I am trying to get vision here. A very basic point with you, and I want you with me.

Mr. GOLDIN. We will work with the National Institutes of Health in a complementary fashion to provide better insight into the gen-

eration of disease, and cure and prevention of disease. And let me point out a couple of examples where this is appropriate.

Because we go into space, I think we have a better understanding on this planet on the source of kidney stones, as an example. When the Russians had some experience in Mir, they called the Americans because their astronauts were building up kidney stones and they did not understand why. So, that triggered a research project that NASA undertook to understand the characteristics that led to the build up of kidney stones.

What were the factors? Was it diet? Was it lifestyle? And we were able to isolate a number of factors that led to the build up of kidney stones. The reason this occurs is when you go into space in low gravity you lose bone mass. The bone mass gets dissolved into the bloodstream. The calcium comes out of the bloodstream and builds up in the kidneys.

So, if we want to live and work in space, we have to understand why you get calcium deposits. We found, as part of that research, that diet had a big impact. For example, we found that animal protein, high animal protein in the diet led to a build up of kidney stones. So, we adjusted the astronauts diet toward that end.

The Russians had been doing incredible levels of physical exercise to keep the bone mass and the muscle tissue in place, and we found that that was not the way to do it. You had to be more efficient than your exercise.

So, these are factors, when complemented with the work going on on the ground, that help bring us a better understanding of the human physiology. It is a research laboratory in space. And if we think about that as another facility, a research facility that complements work going on on the ground or going on to unknown areas, we will be able to get a better perception.

You know, if you think about some of the work that was done on semiconductors in solid state physics 30 years ago, they did not have to lay out a detailed set of circumstances in terms of where it was going to lead. But in the end we got semiconductors and we have improved our quality of life.

This is a research station in space where, in the absence of gravity, we understand changes in life cycle forms and in material science forms so we get better insights into processes that could help us on the ground.

Senator ROCKEFELLER. Let me follow up with one more question on that, and then I will yield at any point to either of my colleagues for questions.

We used to be talking about a much larger Space Station, as indeed we used to be talking about a much larger NASA. But let us just keep it on the Space Station for a moment. And again, my very bottom, very basic line of vision and sort of preponderance of purpose. When an administrator is told to cut a budget, he or she does so because the President says it has to be done. And what often happens is that the numbers decrease but the rhetoric does not. And then there is a fine point at which numbers begin to make a difference and the rhetoric no longer can justify what it previously said. Now, I am still at my basic point. I am not trying to trap you, I am trying to help you here.

You have had to cut on Space Station. The average person would say, you know, when you cut the cost of care in a hospital from $8,000 a day for a complicated disease to $3,000 a day something goes, something changes. The mission of the hospital is forced to be different because of financial constraints.

Without prejudicing you—well, that is your decision—but with these budget cuts in Space Station by almost definition some of the targets, some of the vision, some of the mission, some of the possibilities have to have been diminished or else logic that applies elsewhere does not apply here.

Mr. GOLDIN. Let me respond first by dealing with the concept of logical thinking, because sometimes logical thinking traps us into places where we should not go. And let me pick up on the example of medical care. I want to tell you about an experience that NASA has had with medical care.

Senator ROCKEFELLER. You are going to give me an example, but you are also going to answer your question.

Mr. GOLDIN. I definitely will answer your question, but I want to explain the concept of nonlinear thinking. And let me talk about health care. Heart bypass is about a $40,000 operation, and the patient has to be in the hospital for 10 to 15 days. You are opened up, and it is a very dangerous procedure. And you say, well, let me start working at cutting the cost of a bypass operation. And you say, I do not think I can cut the cost by a factor of 4.

But let me say, I will have nonlinear thinking. I will clear the arteries using a cool laser that will not burn the artery walls, and I will dissolve all the material in the artery. What if I could do that procedure for $10,000. It is a new possibility. I now have a $10,000 procedure where the patient is an outpatient, and I have generated a whole new industry and all new possibilities. I call that nonlinear thinking.

We in NASA for so long on the Space Station have had linear thinking. Every time we had a budget adjustment, all we did is take something away and that is where everyone went to. We, on the Space Station, are taking a look at nonlinear approaches on how we could do more with less.

There is example after example in our society. I will tell you I came from industry where we have had budgetary pressures for years. And it is not until, you know, when industry is fat and the profits are high you do not deal with the issues that you have. You have to deal with a broad range of things and it is more than just technology.

I salute the fact that we have been asked to cut the costs on the Space Station. And we either have to come up with real reasons, or NASA is going to have to say we cannot do a $5 billion Space Station. And I want to commit to you that if we do not think we have a scientific payback and we cannot do enough nonlinear thinking, that we will step forward and say you cannot have a $5 or a $7 billion Space Station.

Senator ROCKEFELLER. That is completely fair. That answers that, and that establishes the openness between this committee and you that I want, so that we are not engaging in semantics or rhetoric in somehow the shading of either of our points of view. I trust your response to that and accept it.

Unless either of my colleagues want to interrupt me, can you discuss a little bit for example, to change the subject, a Pluto fly-by or rovers on Mars. Interpret those again in terms of vision possibilities; the excitement that Senator Burns was talking about in terms of the American people. What can those bring us?

Mr. GOLDIN. First, let me talk from a scientific standpoint and say that Mars is a planet that has tremendous scientific value. Mars and Earth started out exactly the same way when they were formed. And after about one-half billion years, they started deviating. Mars was wet. We believe it had oceans. It had a dense atmosphere, and so did Earth. Mars right now is an icebox with almost no atmosphere, a very thin carbon dioxide atmosphere, and Earth has a robust atmosphere. Just because of that, we ought to understand what happened.

There are other possibilities of what does exist on Mars. What are the possibilities for future civilizations on Mars? As a society, we must know. What child has not gone up and looked at the night sky—and let me come to the inspiration—and wondered, what is it all about?

As a society, if we stop looking out and we stop looking into the future, we are no longer a robust society. So, there is an inspirational aspect. There are a lot of movies and a lot of interest in Mars, so people want to know about it. But there is a very strong scientific reason that will help us understand our own planet a lot better. But more importantly, it will inspire. That's Mars.

Senator ROCKEFELLER. Let me get not just the inspiration but the understanding part. The inspiration I have no qualms with, and it is awesome. In fact, it is big bang stuff. But what are some of the knowledge facts which, in fact, we might gain for our purposes on Earth by understanding what happened with Mars?

Mr. GOLDIN. There is speculation of seismic activity on Mars, and we are talking about putting these little microrovers around with seismic stations and a seismometer built on a chip. Not a big seismometer, but a little seismometer built on a chip. We will understand the weather patterns on Mars. There are winds. It gets pretty vigorous at times. We will understand the basis of how Mars was formed and be able to relate that to how Earth was formed.

We will understand basic geology and we will understand physics. We will understand the chemistry of Mars. What substances exist on Mars? Are there any minerals of interest on Mars? Are there concentrated mineral resources? What happened to the water on Mars? Is there subsurface water on Mars?

There are those that speculate that some of the water on Mars is frozen into the ground. There may be sources of water on Mars. If there are sources of water on Mars, it would certainly make human expeditions to Mars a lot more fruitful.

Wes, would you like to expand on this? I would like to ask our head of the Office of Space Science to come up and say a few words.

Mr. HUNTRESS. Thank you. Let me talk about Mars first. There are two key reasons for being interested in Mars among the nine planets of the solar system. And they are, first of all, the possibility that life might have once arisen on that planet.

As Dan described to you, it seems clear from our previous missions that water once flowed on the surface of that planet, and

there may even have been oceans or large lakes at one time on the planet. There clearly is ice in the poles. There clearly is permafrost on the planet. So, there is water there locked up, if not in the atmosphere. And the question is, did life ever arise on that planet at some time?

The other is the fact that Mars, although having a thin atmosphere, does have a very interesting climate. It is kind of a end member of the Earth's climate. It is thin and it is dry.

Senator ROCKEFELLER. What do you mean by end member of the Earth's climate?

Mr. HUNTRESS. It is an extreme example of what the Earth might have been at one time. In fact, it goes through very large swings in climate. Mars has a very eccentric orbit, and over the coarse of geologic time its climatic state changes. Its surface temperature changes quite a bit, much more so than the Earth, but in a manner similar to the Ice Ages on our own planet.

So, by studying the extreme swings in climate change on this planet, we may understand better the climate changes that occur on our own.

For Pluto, I think the interest of the American public is simply that they are interested in the unknown, and Pluto is the last unknown planet in the solar system. It is the one planet we have not yet visited with planetary spacecraft.

And it is kind of a unique body because it is a small, icy body out in the region where there is normally all these gas giants. Why this little body out there with all these big gas giants? It may be telling us something about the origins of the solar system we do not know.

The gas giants are the four large planets of the solar system. Jupiter, Saturn, Uranus, and Neptune that occupy the outer portion of the solar system beyond the asteroid belt. Pluto is beyond them yet, and we are curious as to why it is there and what it is telling us about origins.

Senator ROCKEFELLER. Did you want to say one more thing? Then Senator Bryan had a question about Pluto.

Mr. GOLDIN. This is another example of nonlinear thinking, and how we are going at things at NASA. We had a dilemma in NASA where scientists always looked upon a planetary mission as the last ship out of town. And if you did not get a payload on that mission, you could not get onto the mission.

And what would happen is people would put a lot of payloads onto the spacecraft. It would increase in weight. As a result it would grow in cost, the launch vehicle would get bigger, the program would get more expensive, and it would take a long time to do because it took so much money.

We tried to break this paradigm when we said to the folks on Pluto, if you have a big heavy spacecraft it is going to take 15 years to get there. It will take 10 to 15 years to get going and to build. That is 30 years from now. By that point in time the atmosphere on Pluto will condense and collapse because it is in an elliptical orbit and it travels away from the Sun, and there will not be an atmosphere to study.

So, we challenged Wes Huntress and the folks at JPL and we said, become nonlinear thinkers. What we want is a spacecraft that

is one-half the size, one-half the weight, one-half the cost, with equal or better science. Think your way through it, because unless you do that—and get it there in one-half the time. You have 7 years, not 15.

They have taken up the challenge at the Jet Propulsion Laboratory and they are looking at new ways of doing things. The old way was I want to be safe. And because it is a national priority, because the program is so expensive I am going to use proven technology. And so by the time you fly it it is 20-year-old technology. Where is the relevance to America?

We have a bunch of excited engineers and scientists at JPL that are taking 1993 technology. They are going to utilize that technology and, in a testbed on the ground with some limited amounts of funds, retire the risk and prove the paradox that less is more. And this is the concept that we have to perform our mission.

And on top of that, we have asked them to get relevant with local industry and make connectivity with local industry so when you develop this new technology you will generate new jobs here on Earth.

The Jet Propulsion Laboratory, under Ed Stone, has built up a whole series of industrial alliances. They are now up to I think some 100 companies that are actually paying money to participate with the Jet Propulsion Laboratory to get this technology transferred. I just wanted to present that as an example of how we are going about doing new things in this new budget, and breaking this paradigm shift that everything has to be big, everything has to take long, and everything has to be expensive and as a result, it is less relevant to the country, rather than more relevant.

Senator ROCKEFELLER. I appreciate that. I want to follow up, but I know Senator Bryan has a question. I know Senator Burns has several questions.

Senator BRYAN. Thank you, Mr. Chairman.

To shift the focus a bit, you tantalized us a bit by talking about the first "A" in NASA. And I would like to have you flesh out a little bit more of what have you in mind there. We have heard a good bit over the last one-half dozen years or so about the prospect of hypersonic flight, or the Orient Express as it was dubbed in the media. And you also talked about the need to be more competitive as a nation with our commuter aircraft industry and the decline, in terms of American production and share of the market.

Could you comment on either of those aspects or anything else that you have in mind in terms of the role of NASA with respect to the aeronautical function.

Mr. GOLDIN. Sure. Let me tell you that our aeronautics program has four priorities. And I will give it to you in priority order. Priority No. 1 is the High-Speed Research Program. And this is to prove that we can develop the technology to build an environmentally sound plane, one that does not damage the ozone layer, one that could take off and land without having high noise level around airports, because worldwide airports are reducing noise levels and keeping American planes out. One that would be economical, so it will not be like the Concorde, where you pay a 10 times premium, but will be a plane available to the total population of the world, so if we could do that, the aeronautics industry estimates between

500 and 1,000 planes could be sold at a multihundred million dollar price tag competitively.

Senator BRYAN. This would be a transpacific type of aircraft?

Mr. GOLDIN. Or transatlantic.

That is the No. 1 priority. The technology involved in building this plane is phenomenal. I want to point out that there is a silent death occurring in America's technology infrastructure. If you go to the third-tier suppliers, they are just coming apart. During a town hall meeting in Hartford, CT, I met with the machine shop operators and the material suppliers to Hamilton Standard and Pratt & Whitney, and they told me as a result of the cutbacks in defense and the cutbacks in commercial aircraft orders, they were going to go out of business in one-half to 2 years.

This is the strength of our country. It is not just the major contractors. When we go forward to build this aircraft, we are going to be reinvigorating the technology base, the advanced technology that keeps these machine shop operators going.

Let me tell you how bad the situation is. The critical technology in building this high-speed civil transport is building a combuster that operates at wall temperatures of 3,400 degrees. Those temperatures are so high you cannot use metals because they would melt. So, we have to use composite matrix materials that have oxides and carbon fibers. The raw materials for this research combuster cannot be procured in the United States because we have fallen behind in carbon fibers.

So, here we are looking at advanced technologies and we are losing all these third-tier suppliers. So, I view this as a crisis. And that is one of the reasons we picked such a difficult technology, to help rebuild the technology base and rebuild that infrastructure. You know, when a road decays or when a bridge decays you can see it. But when a technology infrastructure decays, it is silent and you do not know until 10 years later, when it is too late.

The second priority is to develop leapfrog technology in subsonic transports, long-haul transports. America is losing the market share there. We have lost 25 percent market share since 1969. We cannot just compete and make small improvements, because we have competitors that are subsidized. And if we just make a 10-percent improvement, they just drop their price 10 percent and we cannot compete. So, for the next generation, the leapfrog generation, we need cutting edge technologies that give our manufacturers an advantage. We have got to get much higher lift to drag with radical new approaches to wings. This is called a laminar flow wing.

We have got to bring electronics into the cockpit and build a glass cockpit. We are not taking advantage of our satellite resources; the GPS system could allow us to have planes land in much tighter landing patterns, because we cannot build new airports. And as a result, we could generate a new opportunity for selling new aircraft around the world. So, that is our second priority.

The third priority is the wind tunnel infrastructure. The wind tunnels in this country are 40 years old, on average. They were built in the post-World War II era, and as a result, they are not as productive as wind tunnels in Europe and Russia, and they are

not at the same operating conditions. We need a broader range of operating conditions.

The aircraft industry is saying they have got to build planes in 3 to 4 years from start to the first plane out of the chute, not 8 to 10 years. If we have to take too long in wind tunnels because we have unproductive wind tunnels, what is happening now is the Boeings and the McDonnell-Douglasses are having to go to Europe and Russia to do their testing, giving away their critical technologies.

The fourth priority is the long-term vision, and that is hypersonic or transatmospheric vehicles. We have put in a very robust technical development program to use old Minuteman missiles to launch shapes into space so we could understand boundary layer transition and operation at Mach 25. That is 10 times the speed of the high speed civil transport. And we are going to do this in concert with the DOD, so that 5 years from now, we can understand the barriers to hypersonic flight and, in a systematic way, answer the questions.

The prior program we had was a $10 to $15 billion program that builds an aircraft and then starts asking those questions. So, what we have done is we have stepped back and said, time out. What we need to do is get a very quick set of data in a 5-year period and do it for a very relatively low cost. So, we are talking about more than an order of magnitude reduced funding to get the same data in a more efficient manner.

And those are our priorities.

Senator BRYAN. Mr. Chairman, thank you very much.

Senator ROCKEFELLER. Thank you, Senator.

Senator Burns.

Senator BURNS. Thank you.

As we work our way through this, Mr. Goldin, and we try to justify what we are doing, and I think probably those of us who are involved with the program—and do not get me wrong, this is not a parochial issue with me, there are not a lot of space programs in the State of Montana—but I am concerned that when we start trying to rationalize to our constituents the very essence of NASA, I am concerned that the President has done away with the National Space Council, which I thought sort of played an important role for the President to go on and to use the bully pulpit to really sell this program and to show some leadership to the American people.

Without that Space Council, how will space policy be established at the White House? I guess that concerns me.

Mr. GOLDIN. Well, I could tell you what I understand. Clearly, the White House has talked to the space policy that it has. But I believe that Dr. Gibbons, in his capacity as the President's Science Advisor and head of OSTP, has provided leadership. We have outstanding communication with his office. He has a very, very strong staff there. We are working together. And I believe that it will provide the focus to the President, and it will provide the opportunity for the White House to communicate with the American people.

I ask you to give it time. It is a new office. It is just starting up with some very competent people.

Senator BURNS. Spinoffs of this program—computers, communications initiatives, and this type of thing—and I think we talked about this in our office about where we are going, our national competitiveness in this area. They may be two of the most important technologies that we have in this century. What is NASA's role in this multiagency computer and communications initiatives?

Mr. GOLDIN. I might say that NASA has some of the most demanding needs for computational capability in the world. There are a number of missions that we have that drive it, and let me say that, first, is aeronautics. Ultimately, we would like to be able to fly planes on a computer. And we are orders of magnitude in speed away from it. So, if NASA is to meet its goal and vision in helping the American aeronautics industry rejuvenate itself, we must be on the cutting edge of computation capacity so we can get tools that are not available elsewhere in the world.

That, by far, is the driving requirement for computers.

The second area where we work is understanding the Earth's environment. The computational needs in that area are probably six orders of magnitude greater than we have a capacity to do right now. So, NASA is driving the computational capability of this Nation to give us capacity that we normally would not even ask for. But the amazing thing is, once that capacity exists, it goes right into the industrial infrastructure.

So, NASA is working with the rest of the agencies in developing software techniques that could allow us to do parallel processing, and to be much more efficient in the use of the software.

What we have gone from is central computing that has been in vogue for the prior decades to what is called parallel processing where we have a number of very fast processers operating together. The challenge that NASA has taken on and the major area where we are contributing to this computing program is figuring out how to take the software for a variety of different physical problems and operate that software, instead of on one machine, on parallel machines, without wasting a lot of code and wasting a lot of speed.

So, it is measured as an efficiency, and right now those efficiencies are near 10 percent, and we are shooting to get the efficiencies up close to 80 percent, so we do not lose the speed we gain in the hardware with poor software interconnectivity. And that is the major area we are contributing.

Senator BURNS. Now, let us take the direct spinoff in that area and the area in which I have been working on for four years, which is how we translate the advances we make in educational applications to our schools, especially K through 12. Because that is where the future lies. That is where we trigger the curiosities in our sciences. And how we transmit that—how do we transmit that into the minds of a—then I will get very parochial—how does Montana play in that? And how do we transmit that information to those schools up there that are remotely located?

I have been working on broadband telecommunications, glass, and they will handle this with compressions in the technology we have there, but I would hope that we would have a sense for that on how we implement that.

Mr. GOLDIN. Well, let me say, as part of the high-performance computing and communications initiative, we have an outreach

program that connect into the schools as part of this backbone data network. It is at a lower speed because the schools do not need those high speeds.

Senator BURNS. That is right.

Mr. GOLDIN. And we are doing pilot programs right now. As we work through these pilot programs, we are going to provide these capabilities and make them available on a much broader basis. And we would be pleased to work with the educational system in the State of Montana and have discussions on involving Montana in the process as we get these pilot programs taken care of.

Senator BURNS. Well, I would say, you know, as the program goes on, that is the only way that we stay ahead of the curve. If it is not us, it is 50-some-odd-years old and has very little use at this point. But I am going to say that we have to continually expose our young people coming up, and I mean K through 12. Because I think that is the core. That is the—let us say that is the farm system of our scientists to come. And I just believe that that is very important. And I thank you for your testimony today, and I appreciate your being here.

And I thank the chairman.

Senator ROCKEFELLER. Thank you, Senator, very much.

I have not kept good count of time here. And, Mr. Goldin, I find that I can only do about another 20 minutes.

You have implied and said in your testimony that the whole concept of dual-use technology, use to the economic system, economic competitiveness, is very important to you. And that is welcome news.

NASA, I guess you could define it in a sense, is mission-driven, in the sense that technologies have to work in space that are either impractical or inexpensive or not applicable or whatever for a lot of commercial use. Communications—argue with me if you want on this—some of NASA's communications and robotics development perhaps are examples of this.

Now, dual-use is much more likely if it is part of the original technology development. In other words, if it is not spun off, but it is part of the planning as you go in. What do you plan to do about that in terms of future planning and procurement contracts?

Mr. GOLDIN. We have as part of the President's budget for 1994 a very aggressive, proactive outreach program which says we want to involve the full cross section of the industrial base of this country as part of the planning for these activities. And toward that end, we are having meetings that we are going to start holding in about 3 or 4 weeks from now, meeting with various sectors.

We are going to meet with small entrepreneurial companies. We are going to meet with minority-owned businesses. We are going to meet with minority universities. We are going to meet with major technical universities in this country. We are going to meet with the major aerospace contractors.

I have had my first meeting already with the Aerospace Industries Association. They have gotten the chief engineers of the major corporations together, and I have talked to them about this subject. We are going to meet with——

Senator ROCKEFELLER. But as you are meeting and talking, again, designing in and specifically discussing dual use, just as——

Mr. GOLDIN. Proactive dual use. That is the subject of these conversations. So, we are presenting, this is the NASA budget, and we are asking people how could NASA contract in a more efficient manner so we get dual use built in from the beginning, instead of being a reactive process later on. How could we build incubator companies at universities that will partake in the research from the very beginning, small entrepreneurial companies where three-quarters of the new ideas get productized in America, and we want to get arrangements with the universities that we have working for NASA.

Senator ROCKEFELLER. Well, help me understand, though, how that might work. This small entrepreneurial firm gets in contact with Dan Goldin's office. How does dual use on the front end get built in within their scope of thinking?

Mr. GOLDIN. When we go out with requests for proposals, we are going to incentivize them to have them describe to us the process for the dual-use technology. We are going to ask the universities to partake in this. In fact it is not just Dan Goldin, it is a whole management structure. We have nine teams that we have set up to establish how we could go from reactive to proactive. So, until we sit down and talk to these people, I am not prepared to say it is going to be this approach, that approach, or the other approach.

Senator ROCKEFELLER. Fair enough.

Mr. GOLDIN. But what I am saying is we have a formal process that we are setting up. We are going to collect the data. And we are not just going to talk to the large aerospace manufacturers; we are going to talk to the automotive companies, the steel companies, the textile companies. We are going to connect them into a very basic infrastructure.

If you look at our program, we have these research institutes that we are setting up. These institutes are areas where we have centers of excellence in specific fields: biotech and biomed, robotics, artificial intelligence, manufacturing, fluids and combustion, aeronautics. These institutes are being set up not to be a place where we put a brick and mortar. We are going to use existing facilities and take advantage of facilities that already exist. But we are going to ask small companies, universities in aerospace and nonaerospace, to come together as a place where this catalytic action could occur, and we are locating them geographically around the country.

We want to have cost-sharing arrangements. In fact, we have some data for our first institute, the Aeronautics Institute. One industry has indicated they are willing to put in between $10 and $30 million to cost share as part of this technology transfer into dual use. So, we are right at the embryonic stage. But what I want to say to you is the process has been set up and we intend to operate to that process. And it is not going to happen in 1 or 2 months. This is going to take a couple of years to get into place.

Senator ROCKEFELLER. Good. That is a much better answer and that is a good answer and I accept that answer. And before I go to Senator Lott, I would be interested—because I am very interested in process. And in the scaled-back approach but very aggressive approach, and in also a very open approach, process becomes extremely important.

I would love to see, for example, one of the letters that you have sent out, and I would love to talk with you—I would like to talk with you about how those meetings, or one of your nine teams—how small entrepreneurs or, for that matter, large entrepreneurs, how they react? Are they intimidated by that? How do they settle themselves into thinking about dual-use capacity with something called NASA?

Senator Lott has come, and I want to recognize him for any questions he might have.

Senator LOTT. Well, thank you, Mr. Chairman, and I do apologize for being late. Thank you for recognizing me quickly.

I want to welcome Mr. Goldin and Mr. Allison back to the committee. They have been here before. And I want to say that I know from having watched you work, Mr. Administrator, that you are wrestling very hard or very aggressively with a number of problems. And you are trying to comply with congressional directions and the administration's new goals that they have given to you, and I have every confidence that you are going to be able to continue a viable space program that reflects the changing times, if you will.

I noticed in the media this past week that Russia, in spite of its implosion in so many ways, continues to have a very active, aggressive space launch program. Is that not true and what does that say about the priorities of where they are putting their money?

It says to me that they feel like there is a lot to be gained, even in their very difficult straits financially, from the science and technology that comes from the space program. Exactly what are they doing now, just as a capsule, so that I can lead into some questions about our own program?

Mr. GOLDIN. Let me tell you, I have been to Russia twice and the Russians have been to this country. And they told me the very last thing to go in Russia is their space program, because they view it as crucial to their future. They are absolutely committed to it. People all across Russia are committed to the space program.

Senator LOTT. And why is that? It is not a military component alone, or not even primarily military at this time, although in the past, obviously, that has been part of what they were doing?

Mr. GOLDIN. It is in their blood. They believe in it; they understand it. In the United States we have debated the space program longer than we have performed on it, and we continue to adjust the space program incrementally each year and we do not look upon the space program as a long-term vision in this country.

The space program has drifted. We have had 25 years of drifting with the space program. And if we are to have a vital space program, America has to decide it wants a space program, commit to a space program. And then NASA is going to have to perform to a set of expectations. We are going to have to measure ourselves just like industry measures itself, to show the American public that we are delivering for them.

Senator LOTT. Well, I certainly agree with that. And I believe the American people do support a space program, a very active space program. I think that they support certain parts of it, obviously, more than others. They want it to be productive and show results.

They want it to be safe, and there are a whole lot of expectations they have.

But I think most Americans do appreciate the fact that it is not something we just do as a game, but there are direct, clear benefits to come from the space program. But in order to have a viable space program, you have to have at least a certain amount of money, so let me run through some questions here.

I take it that you do support and would like to have the $15.3 billion budget request for fiscal year 1994?

Mr. GOLDIN. Yes, sir. We would like to have it. What we would really like to have is a 5-year budget commitment to NASA, because if we go through each year and each year we cut and trim—and one of the sins at NASA has been, and I think Senator Rockefeller has pointed it out, we have been too responsive to the Congress. And my belief is that if we do not get stability into this program and we keep putting people on and off, and on and off programs.

Of the money scheduled to be spent on Space Station—one of the contractors just showed me this data—24 percent goes into hardware. We are at a point where we have got to stop planning and changing and planning and changing, and start building hardware. Our launch systems are in a terrible state of affairs, the expendable launch vehicles. America lags the world, even though we have all this wonderful technology, because we debate launch vehicles longer than we actually produce them.

So, in my mind I believe we have got to get some commitment to the space program and move on. And the position that NASA is going to start taking is if there has to be cuts, we are no longer going to start squeezing, we will just recommend termination of programs. Because the instability that we get by replanning and reprogramming and replanning and reprogramming is paper and not hardware. So, we want to be responsive, but we also have to be responsible.

Senator LOTT. But are you not in fact redesigning the Space Station at this very time?

Mr. GOLDIN. Yes.

Senator LOTT. So, you are making a substantial change there from the whole program we envisioned to the so-called—you probably do not like this terminology, but "man in the can." A much smaller program than what was originally envisioned, but within the money you have and the direction you have been given from the administration, you are trying to change that program to be less magnificent in its design. Is that true?

Mr. GOLDIN. Well, under directions from the administration, we were presented a problem. We were given a 5-year budget run out that had $15 billion less than we could accommodate, and we were also told by the administration they wanted a much more cost-effective Space Station. This was a directive.

And we said we will look at the Space Station and we will see if we can come up with solutions at $5, $7, or $9 billion. Our position is if we cannot come up with the $5 billion Space Station, we are going to say so. We are not going to come up with a design and then get ourselves into the same situation we were in before where we cannot produce because we keep changing. So, we are going to

try and come up with a set of results and say, okay, here, we have done it. We ask that once we make this decision, let us get on the road and let us not go debate it again; let us go build it.

Senator LOTT. Well, I certainly congratulate you for that and I hope you will stick to that. If you cannot come up with a program or if you are squeezed further in such a way that you cannot even get at this smaller design, and if it does get to be a question of what results we can get in safety and a number of other things, I think it would be better to come up here and say at this cost, you know, we just cannot go forward.

But you do have a 7-percent increase in authorization over fiscal year 1993, and the budget request does include full funding for the Space Station, $2.3 billion, the space shuttle, and the Advanced Solid Rocket Motor Program which will develop the new boosters for the shuttle. Is that correct?

Mr. GOLDIN. That is correct. The $2.3 billion, however, includes some combination of advanced technology and the Space Station. The exact numbers will not be known until the middle of June.

Senator LOTT. Now, there have been some obviously recent problems, and I presume there have been some successes too. I do not know if you have been asked about this, but there have been reports and questions raised about the safety, for instance, of the current solid rocket booster. And there was a situation where you had the wire cutters found in the shuttle on April 8. In September 1992, a booster had to be disassembled.

Are you dealing with these problems and the safety problems, and what are the things you are getting accomplished right now that would justify our continuing to go forward with the space shuttle and moving on to Space Station?

Mr. GOLDIN. Let me say the following. The shuttle is a very complex system. The shuttle has thousands and thousands of parts and it has tens of thousands of people who are dedicated to having each and every flight a success. It takes a motivated team of people that treat safety as the number one priority—and I want to tell you, the No. 1 priority at NASA is shuttle safety; there is no higher priority.

We do have issues and problems that come up, but the way we are going to deal with these issues and problems is to not go search for the guilty and then punish the innocent and seek some blood. We have to rely upon trust as the key in building and operating the space shuttle, and that trust says that when we have problems, we try and understand the process problems and go in and fix the process problems. And that is exactly what we are doing.

Jed Pearson, who is the head of the Office of Space Flight, has a letter from me asking him to review the processes that led to the problems, to understand what went wrong with those processes, and to fix the problems, not to fix the people.

Senator LOTT. Mr. Chairman, if you will bear with me just a minute more, two brief questions. One, you do support the continued development of the advanced solid rocket motor engine.

Mr. GOLDIN. Proposed it in the budget.

Senator LOTT. And I believe that the Clinton administration has indicated a need to increase the emphasis on transferring technology to the private sector. I have always advocated that, going back over 20 years. I think that there is an awful lot of good things

that NASA does, a lot of good information they have that could be used in the private sector that somehow winds up on shelves or within NASA and they never get communicated out into the private sector.

Again, I do not know if you have been asked about that, but do you have a plan designed to energetically try to transfer that information, that technology, that scientific information that you develop, to the private sector?

Mr. GOLDIN. We have done well at NASA, but not good enough. One of the things we did last year is I asked the employees to form a team to take a look at how effective we were at transferring technology. And they came back with a report to me which said NASA has done a good job, but it is not outstanding. And the primary problem was that at NASA the only thing that counted was the mission, and there were no rewards for the employees for dual-use technology.

So, the NASA employees had the courage to walk into the administrator's office to say we were not doing a good job, which I felt was a reward to me because there was an environment where employees felt they can criticize their own agency. As a result, I sent a directive to each of my direct reports that runs the different offices, to say the dual use of technology is as important as the NASA mission, and you are to factor that into the process. That was the starting point of the process that I had talked to Senator Rockefeller about.

So, we are going to transition from a reactive approach, which says well, we have done these wonderful things, here, come and get the goodies, to a proactive approach which says, America, NASA is on the cutting edge, we want to share these technologies, tell us what you need.

And let me give you an example of what happens in a European country. There is a European country with a space agency that holds meetings. They go out to the industrial base and say we are going to have all these missions that we are going to do; could you tell us what your needs are in terms of industrial base technologies, to help us prioritize the missions we are going to undertake so we can then transfer that technology into the economy.

I hope we can do even better than that. But I want to point out from the perspective standpoint, we have taken the first step and we are just into the early stages of the process. And as I pointed out before, this is going to take a couple of years. I do not want to misinform people to let them think this is going to happen in days or weeks or months. This is a multiyear process.

Senator LOTT. I hope you will. I think the people are entitled to it. I think it would be very helpful to the economy and the private sector. And also, quite frankly, I think it would help NASA people have a greater appreciation for what you, in fact, do.

I look forward to working with you this year, and I certainly will support you and your program and I hope we are successful.

Thank you, Mr. Chairman.

Senator ROCKEFELLER. Thank you, Senator Lott.

Let me just pick up, Dan, for what has to be unfortunately my final question. You began to talk now about the commercialization

incentives, disincentives for personnel. They have not been there in the past, and you walk right into the whole CRADA situation.

And one of the problems, I would guess, in the past has been that non-NASA engineers and researchers and others, and just business people, have not felt that what NASA is doing is something that they could dual use or could commercialize. And experience, in fact, has indicated that such efforts do not really work unless there is a change in personnel processes, personnel incentives.

Now help me understand, if you have a CRADA arrangement with private industry and you want to develop a more entrepreneurial atmosphere, that applies not just for the private sector but also for the public sector employee. In other words, if a NASA employee makes a discovery in one of these CRADA arrangements, they cannot only have it patented, if that is the right word that I am looking for, but they can also reap the financial rewards of that should it be commercially successful. Am I right about that?

Mr. GOLDIN. Well, we have nine committees that we formed. One of the committees is entitled "employee motivation and incentives." So, we just formed these committees, I think 4 days ago. We are planning on getting together with our legal counsel and getting together with our technical people, or people in the commercial area, to try and see how to deal with it.

You know, when one is in Government there are a set of regulations that are in existence. So, if we find a stumbling block, we may come back to the Congress and say we want to motivate our employees. I do not know that we have them or not, but if we do feel we have a problem where we want to financially motivate our employees are there are some laws that do not allow us to do it, we might come back and ask for some help.

Senator ROCKEFELLER. Yes. See, what is interesting about that is that the feeling about NASA, if one just looks at it from the outside, is that it is huge in scope and that therefore an individual is not able to intervene or intercede in a way, or interact in a way which would make much of a difference. So, that the whole concept of making NASA user friendly, psychologically as well as in fact, to the entrepreneurial community becomes extremely important. And, obviously, part of that is personnel rewards.

So, if you are saying you are just starting that process, then my question is probably premature. But how, both on the private sector and the public sector—and, obviously, first on the private sector—how do people feel that they can gain from that? Not just an individual but a company would get into this for commercialization purposes in a CRADA arrangement, because they could in fact—you know, with a patent or a discovery, that that would be theirs to use. That becomes very important, and you say you have not made any decisions on that, you are just beginning to discuss it.

Mr. GOLDIN. On the NASA side. But let me give you some data. At the Jet Propulsion Laboratory, I think about 3 or 4 years ago, they had eight companies that were part of the industrial alliances that they had. I think there are now over 100. Companies are paying money to participate with NASA because they think that there is an opportunity.

Senator ROCKEFELLER. See, that is very very healthy. That is very very healthy.

Mr. GOLDIN. Jack Lee, who runs NASA Marshall Space Flight Center, has a set of public institutions and private companies that are working with NASA Marshall. I think they are up to 300 institutions that are working with them, that participate in their manufacturing productivity center.

Senator ROCKEFELLER. Yes. Well, that is very good and very helpful. The American people are amazing sometimes. All of a sudden in the last 3 or 4 years, without any particular driven directive, the top 25 percent of our graduating college seniors are going into teaching, as opposed to earlier when it was the bottom 25 percent. And there was no advanced directive or anything that made that possible, it is just the American people responding. So, you may be seeing the same thing in private industry, which if that is the case, that is very very encouraging.

I have to cut this off now, and I apologize because I have more than I want to talk about. But it is a good first hearing. We will stay in very close touch. And I thank both of your for your courtesy and helpfulness. Thank you.

[Whereupon, at 12:26 p.m., the hearing adjourned.]

APPENDIX

Questions Asked by Senator Burns and Answers Thereto by NASA

THE FUTURE ROLE OF NASA

Now that the Cold War has ended, our biggest battles are in the high-tech markets like communications and electronics. At the same time, concerns about the federal deficit have made Congress and other policy makers extremely cost conscious.

Question 1. What is NASA's role in this changed environment and what adjustments are you, as NASA Administrator, trying to make to ensure that NASA is meeting national strategic needs like competitiveness and does not become irrelevant?

Answer. The NASA program has been traditionally a source of technological strength for the U.S., both in aeronautics and in advanced technologies from space activities. NASA is making major investments in technologies that are needed for future U.S. economic competitiveness. A comparison of the technologies that are crucial to NASA's programs (e.g., in space science, in aeronautics, in Earth sciences, or other areas) to the technologies identified by the industry-led Council on Competitiveness in 1991 clearly indicates the significant positive impact NASA's programs can have in this area. However, working in relevant areas is not enough. In addition, NASA is working to strengthen the transfer of its technologies and its partnerships with U.S. industry. In the FY 1994 budget, NASA and the Administration have proposed a robust package of new technology investments. These investments will be made in direct partnership with U.S. industry and universities to assure that the technology developed for aeronautics and space are immediately available for application in the non-aerospace economy.

Question 2. What do I tell a small businessman in Butte, Montana, who asks why we are spending $30-$40 billion on an orbiting Space Station when the deficit is spiraling and folks are out of work?

Answer. Over the past three decades the space program has developed many technologies that have had secondary uses on Earth. By advancing the state-of-the-art, programs such as the Space Station can provide breakthroughs in technology that enhance current industries or create new ones, providing for economic growth and the creation of jobs. Because of research and development work done on NASA programs, many new technologies are developed sooner than would be possible without them. In today's competitive international marketplace, industries that fail to take advantage of new technologies are at a distinct disadvantage.

From the development and operation of the Space Station, useful applications are likely to result in the development of better alloys, more efficient semiconductors and solar energy systems. The life sciences research can help with medical treatment, crop yields and water recycling and filtration systems. Increased knowledge in the area of human-robot interaction can lead to improved manufacturing equipment and processes. All of these are applications which can help the economy, strengthen our international competitiveness and Improve our quality of life.

COST OVERRUNS

In past years, NASA has presented Congress with "low ball" cost estimates for major new programs and then was forced to ask Congress for substantially more money when the real costs materialized. In fact, in a recent GAO study of 29 space programs, virtually all of them required much more funding than originally estimated.

Question 3. What is NASA doing to correct this problem and present Congress with realistic cost estimates for new and ongoing programs?

Answer. NASA is moving ahead with many management and procurement reforms. The Administrator has established a Program Excellence Team, headed by Dr. Howard Robins Jr., Deputy Associate Administrator for the Office of Space Systems Development, to establish new program management procedures that speak

specifically to this concern. These procedures will address program formulation and implementation to assure that NASA management will have a better understanding of the costs and risks of any new program before requesting new start authority from the Congress. NASA is planning to initiate many of these reforms as pilot tests, and then implement them across-the-board when their efficacy has been assessed. In the meantime, a transition plan has been put in place whereby the newly-established Program Management Council, headed by the Deputy Administrator, will review and validate all Research and Development programs, including requirements definition and acquisition planning, the development estimate of which exceeds $200 million.

Question 4. Do you believe a regular independent review of NASA's cost estimates is needed on all major programs?

Answer. As part of a strengthened emphasis on program management, the Administrator has committed to independent cost reviews at significant program milestones (e.g., PDR, CDR, Launch-2 years, Launch-1 year). This evaluation of the technical, schedule and cost progress of a program will provide an overall assessment of the status of the program at critical time periods. In addition, NASA plans to increase the size of the Cost and Economic Analysis Branch, within the Comptroller's office. This office conducts independent cost estimates, without ties to any specific program offices. The results of these assessments are provided directly to the Administrator.

COMPUTERS AND COMMUNICATIONS INITIATIVE

Question 5. I believe computers and communications may be the two most important enabling technologies of this century. What is NASA's role in the multi-agency computer initiative?

Answer. The National Aeronautics and Space Administration's High Performance Computing and Communications (HPCC) program is part of a Presidential initiative aimed at producing a 1000-fold increase in supercomputing speed and a 100-fold improvement in available communications capability by 1997. NASA will use these unprecedented capabilities to help maintain U.S. leadership in aeronautics and Earth and space sciences by applying them to a wide range of scientific and engineering "Grand Challenge" problems. These are fundamental problems whose solution requires significant increases in computational power and are critical to meeting national needs.

The main objective of the federal HPCC program is to extend U.S. technological leadership in high performance computing and computer communications systems. Applications of these technologies will be widely disseminated within the U.S. government, industry, and academia to accelerate the pace of innovation and serve the U.S. economy, national security, education and the global environment. They also will result in greater U.S. productivity and industrial competitiveness by making HPCC technologies an integral part of the design and production process.

NASA's role in the program includes leading the development of applications software and algorithms for massively parallel computing systems which will increase system performance to the sustained teraFLOPS (10^{12} floating point operations per second) level. As HPCC technologies are developed, NASA will use them to solve its Grand Challenge research problems. These include improving the design and simulation of advanced aerospace vehicles, enabling people at remote locations to communicate more effectively and share information and increasing scientists abilities to model the Earth's climate and forecast global environmental trends. NASA also plans a new initiative to broaden the reach of the HPCC program and begin the development of a National Information Infrastructure by supporting research and development in education, digital library technology, manufacturing and design and access to Earth and space science data.

Question 6. I am also interested in developing educational applications for advanced computer technologies. I think a special focus should be on K-12 education since young people develop an interest in math and science at a very young age. What are your thoughts on how the computer initiative can be used to enhance the U.S. educational program?

Answer. NASA is leading a key element of the Federal government's involvement in educational technology by chairing the Educational Technologies Working Group of the Federal Coordinating Council for Science, Engineering, and Technology's (FCCSET) Committee on Education and Human Resources (CEHR). NASA has established educational technologies as one of the three key enabling capabilities in its strategic plan for education, Strategy for Change, Educational technologies being supported include telecommunications systems for information delivery to educators,

multimedia products, and research and development into the classroom of the future.

NASA believes that technologies developed under the High Performance Computing and Communications (HPCC) program can create unprecedented opportunities for learning complex ideas by creating an environment that closely approximates the real world. They allow for instruction tailored to individual learning needs for people with learning disabilities and for retraining adults who possess a variety of needs and abilities that are often inappropriate for traditional instruction. HPCC networking technologies also play a valuable role in education and training by enabling students to work together as part of a team even when some team members live in remote areas.

In fiscal year 1993, NASA plans to focus greater resources in this area by initiating five to eight pilot projects to develop digital aeronautics and space science educational materials for distribution over the National Research and Education Network (NREN). NASA also is considering ways to produce there materials based on remote-sensing data and plans to establish programs that enable teachers to evaluate and utilize NASA educational education products.

In FY 1994, NASA will continue these pilot projects in order to reach out to and even larger number of people and will initiate more pilot projects in other areas of the country.

It is our understanding that students in Montana will be able to tap into these resources through the educational network it has developed for K-I2 institutions called the Big Sky. This network, which is connected to the Intemet, will be able to access all the educational resources that NASA distributes of the NREN.

Question 7. I would think that computer advances will enable NASA to reduce costs and become more efficient in designing spacecraft and aircraft. How do you see computer technology positively impacting the U.S. space program?

Answer. NASA's planning and research in supercomputers has allowed it to achieve significant cost savings in preparing for future year budgets. As part of its FY 1994 planning activities, the NASA Aeronautics Program examined its strategy for investing in operational supercomputers during the FY 1993-1998 time period. We proposed a strategy that accelerated a transition to new high performance computers developed under the High Performance Computing and Communications (HPCC) program. The result was a savings of $35 million in the overall NASA budget and a significant increase in the computational capabilities over those previously planned during that period.

NASA also recently entered into a cooperative research agreement with industry to examine the use of supercomputers in speeding and improving 'the design of advanced spacecraft. This effort will result in spacecraft that have significantly greater capability and can be developed faster and cheaper. NASA also is performing research on embedding high performance computers in unmanned vehicles to enhance the scientific returns from these vehicles.

AERONAUTICS

To many on Capitol Hill, NASP has the potential to be the most dynamic of all the NASA programs because its potential benefits spread across aviation, civil space and the military. I think it is a positive signal that you have asked for $80 million for NASA's part of the NASP program.

Question 8. What is the current status of the NASP and when will we see the development of the actual NASP prototypes?

Answer. The National Aero-Space Plane program is making significant technical progress. It has approximately one year remaining of the current technology development period, during which the program has advanced a wide range of technologies and integrated them into the design of the future flight research vehicle, the X-30. The NASP program is unique in that it is developing technologies to test on an X-plane; other X-planes were constructed with the best technology available at the time and therefore required no significant technology development.

The currently proposed risk-reduction option would insert a six-year period of technological development, ground and flight tests, into the current program in order to maintain technological momentum while lowering technical risk associated with the X-30 and respond to near-term budget pressures. The risk reduction would be accomplished with flight tests of rocket-boosted, subscale test vehicles combined with complementary ground-based technology development, testing and analysis. The first flight could be as early as 1995. The activities would be focused on key areas such as scramjet performance at Mach 12 to 15.

The decision to build and fly the X-30 would be expected in the FY 1998-99 timeframe, with first flight of the X-30 about four to five years later. A derivative vehicle

could possibly serve as a prototype for a revolutionary generation of future space launch vehicles.

Question 9. What steps is NASA taking to help the U.S. aircraft industry be more competitive against its heavily subsidized rivals?

Answer. While foreign competition certainly is a major challenge to the U.S. aircraft industry, it is only part of the changing environment in which a number of challenges must be addressed, including the end of the Cold War, the globalization of the aeronautics industry, and the need to improve the efficiency of our national aviation system, upgrade safety and resolve environmental concerns. Advanced technology is a critical element of the Nation's response to all of these challenges, and NASA's role is to develop this technology.

NASA has an aggressive program in aeronautics which is designed to enable U.S. industry to compete more effectively in world markets, ensure U.S. preeminence in military aviation, and secure the safety of our national aviation system. In FY 1994, NASA's budget request for aeronautics is up 18 percent over FY 4993. This increase will be used primarily to expand our civil aviation programs in support of U.S. industry in three key areas: high speed research, subsonic research, and national facilities.

The objective of NASA's High Speed Research (HSR) program is to lead the development of the highest risk technology that will allow industry to build an economical, environmentally friendly commercial aircraft that industry studies indicate will fly at two and a half times the speed of sound, carrying 300 passengers over 5000 nautical miles. The studies indicate a potential market of 315,000 passengers per day in 2000, increasing to 600,000 in 2020. This translates into a market of 500-1000 High Speed Civil Transport (HSCT) aircraft. The HSR program is being carefully planned and executed with industry as a full partner, to ensure the program meets industry needs. We are working to solve critical environmental issues such as noise and emissions as well as to develop technologies that will make the aircraft economically viable and profitable for industry to build and operate. If funding and schedules remain steady, a U.S.-built HSCT could be certified by 2005, guaranteeing the preeminence of U.S. industry in the world aircraft market well into the future.

Because subsonic aircraft will continue to handle the dominant portion of passenger traffic even after new high speed transports are flying, NASA is proposing to aggressively augment the Advanced Subsonic Technology Program in FY 1994. This program is specifically focused on giving back the competitive edge to U.S. companies by developing technologies to increase aircraft efficiency, improve safety, and reduce development costs. In addition to very close coordination with industry in planning and executing the subsonic research program, NASA also has a very fruitful partnership with the Federal Aviation Administration (FAA) which contributes to aviation safety and the competitiveness of U.S. industry.

Perhaps one of the most visible ways this country can ensure its aviation industry remains the best in the world is to maintain the best, most productive aeronautics research and testing facilities in the world. NASA and the Administration are committed to providing industry with the world's best testing capability, and are currently investigating appropriate ways to accomplish this. Many European facilities offer higher quality test conditions and productivity than do our aging research tunnels. Preliminary results from our National Facility Study indicate two new facilities may be needed to keep U.S. companies and their technology at home: a high Reynolds number subsonic tunnel and a high Reynolds number transonic tunnel. These would be production tunnels to allow industry to test large pieces of equipment at near-flight conditions and obtain a lot of data in a relatively short time.

In addition to our strong commitment to civil aviation, NASA Aeronautics also encompasses important dual-use technology programs which have civil applications. For instance the National Aero-Space Plane (NASP) program, which is conducted jointly by NASA and the Department of Defense, is advancing technologies in computer sciences, material sciences, combustion/propulsion technology, instrumentation and special subsystems. NASP invigorates the national technology base in general by pushing the boundaries of technology. A list of technological spinoffs and applications is given in an attachment entitled "Value of NASP to this Country." NASP also benefits the U.S. aircraft industry through the direct involvement of five major companies in the NASP contractor team Lockheed (Ft. Worth), McDonnell Douglas, North American Rockwell, Rocketdyne, and Pratt & Whitney. Numerous other firms and hundreds of second- and third-tier contractors participate in the NASP program.

Question 10. As I understand it, for NASA to solve the unique engine problems associated with the space plane, there is a need for a facility capable of testing engines at temperatures in excess of 3500 degrees fahrenheit. What are the problems that need to be solved and the test facilities role in solving them?

Answer. There are a series of physical and chemical parameters to match for complete simulation of the flight environment for high-speed engine testing. Above a simulated flight speed of about Mach 4, it is very difficult to provide the required match of temperature, pressure and chemical properties of the air. Above Mach 8, the challenges of ground-based testing for aeropropulsion are virtually prohibitive, except for pulsed-type facilities with very brief run times (milliseconds). Some significant questions still remain about test flow conditions, such as contamination and turbulence effects. In general, practical limitations related to physics, power requirements, and cost limit facility size and performance.

Existing ground facilities have been key contributors to the NASP program; some have played significant roles in determining the performance and operability characteristics of large- and sub-scale scramjets up to Mach 8 conditions. Others have obtained similar data on scramjet components at speeds up to Mach 18. However, full-scale flight research is essential to provide the complete answers on scramjet performance; X-planes can be considered flying wind tunnels.

Question 11. Is any consideration being given to locating the engine test facility near colleges and universities that train people in the disciplines you need? Is any consideration being given to locating the test facility in the country's heartland outside of areas which enjoy a large concentration of technical institutions?

Answer. Currently projected funding levels and associated program content for NASP do not support plans for major new facilities. However, there are ongoing plans to involve a limited number of colleges and universities in NASA-sponsored efforts to establish academic centers of excellence in hypersonic technologies. Details of this program are being advertised to colleges and universities; there are no limitations relating to geography.

Question 12. Are you satisfied that the Nation will have enough trained scientists and engineers to meet the space plane's needs and to keep our aerospace industry competitive into the next century?

Answer. Recent reductions in the magnitude of the NASP program and other factors are having an adverse impact on developing a new generation of scientists and engineers trained in hypersonic technologies. Equally significant, the cadre of such specialists existing today contains a very large number of individuals who can be expected to retire in the next several years; this will eliminate a very significant portion of the Nation's "corporate knowledge" in these fields.

MHD POWER GENERATION

As you may know, MHD power generation evolved from the space program. Much of the basic technology rests on re-entry physics, fluid dynamics, gas kinetics and material science. The Department of Energy's principle MHD test facility is in Butte, Montana. It is used in the development and testing of materials at 4500 degrees F. and under extreme electrical and pressure conditions. The scientists and engineers that operate it were trained in the aerospace sciences. It is also in close proximity to the Montana State University at Bozeman and the College of Technology (1) at Butte. Both are premier engineering and scientific schools in the mountain states. The federal government has invested nearly two hundred million dollars in the facility.

Question 13. Couid you envision a role for this testing facility (DOE's MHD test facility in Butte, MT) in NASA's aeronautics or other programs?

Ahswer. The possible role of the Department of Energy's MHD test facility in NASA's aeronautics program requires a full understanding of its technical capabilities and comparison with our planned requirements. Discussions with representatives of the MHD facility have been initiated and meetings are planned to continue this process.

["National Aero-Space Plan—Value of NASP to this Country—The Return on Investment From a National Perspective, November 12, 1992," may be found in the committee files.]

○

67-115 O - 93 (56)

BOSTON PUBLIC LIBRARY
3 9999 05982 111 4

ISBN 0-16-041118-1